SAE JOURNAL

APRIL 1947

The Cover

● Expanding production facilities for manufacturing cars, trucks, buses, and their component parts made scenes such as that on our front cover an automotive commonplace.

Here a medium-sized hydraulic press is being rigged into a new location, the machine having done its part in winning the war.

The world's largest buyer of new machine tools, presses, conveying equipment, testing, and other manufacturing equipment, the automotive industry has led all others in expenditures for new labor-saving tools and processes.

Tool engineering departments of many automotive manufacturers are larger or as large as those of the machine and equipment vendors which sell to the industry.

For the Sake of Argument

By NORMAN G. SHIDLE

Industry abounds with executives who crave publicity and executives who dodge it on principle. They like or dislike it on about the same basis as they like or dislike spinach. Those who enjoy it consider their opposites to be introverts. Those who don't like it cry "Show-Off" and "Egotist" at those who do.

Impersonal thinking about personal publicity would fashion better decisions.

Each man has a job to do. He can do it better if other people understand him. Sensible personal publicity is a help to that understanding. And he gets personal publicity when he writes a letter, speaks to an associate, or answers the telephone – not only when he makes a speech, has articles written about him, or gets his picture in the paper.

If he holds a job so important as partially to integrate his identity with that of his company, having himself understood helps the company to be well regarded. In that case, he has no more right to refuse reasonable publicity of the speech-article-picture type than to boggle at a business trip because he would rather sleep at home . . . and no more right to get himself *oversold* to outsiders than to add to his income by chiseling on an expense account.

Small fry have publicity obligations only to themselves. They have a right to do things the hard way if they wish. But craving too much or permitting too little personal publicity *is* the hard way.

People are fond of saying that they believe what they see. Equally it is true that they see what they believe.

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And the Challenge Met . . .

Year after year, SAE continues to "anticipate the future's challenge for growing reliability and efficiency in air travel." Increasingly, it helps meet that challenge by making available technical knowledge in the highly specialized field of aeronautical engineering.

A specific stimulant to this effort is the Wright Brothers Medal, awarded each year to "the best paper on aerodynamics or structural theory or research, or airplane design or construction" presented before SAE. Originated by the Dayton Section, its administration was assumed by the national Society at Section request.

Ever since 1928 (with the exception of 1938) there has been presented before the Society a paper deemed worthy of receiving this high honor. This month, Frederick V. H. Judd's name will be added to the long line of distinguished recipients.

It is significant that the roll of fine papers to win the award is symbolic of hundreds of other almost equally great presentations which annually compete for the honor.

Geo. H. Page Jr.

Chairman, Wright Brothers Medal Board of Award

WHAT'S IN THIS ISSUE

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Air Navigation Facilities

EXCERPTS FROM PAPER* BY

WILLIAM A. M. BURDEN

Assistant Secretary of Commerce

DESPITE the fact that the 1946 safety record of domestic airlines is over twice as good as that of passenger cars, all of us who are professionally concerned with air transport are convinced that the greatest present obstacles to rapid development of mass air transportation are still lack of safety and lack of regularity.

The present level of airline safety is only one-tenth as high as that of trucks and buses, the common carriers with which aviation must compete. Furthermore, the airlines' regularity record is extremely poor. During winter months the industry completes less than a quarter of its trips within a half hour of schedule.

Greatest single factor in achieving a really major improvement in safety and regularity lies in improving our system of air navigation facilities. Such improvement involves a financial problem, and a technical one.

It is generally agreed that provision of air navigational aids is the responsibility of government, just as the federal and state governments provide highways for vehicles, and radio aids and lighthouses for ships.

William A. M. Burden

$100 Million Spent

Although infinitesimal as compared with the $35,000,000,000 which federal, state, and local governments spent on streets and highways during the past 20 years, from fiscal 1925 through fiscal 1947 the government has spent $100,000,000 for radio aids to navigation, light beacons, and intermediate landing fields in the continental United States, and has spent another $220,000,000 on their operation. This total of $320,000,000 is almost as great as the $343,000,000 paid for domestic air mail in the same period.

Our system of air navigation facilities consists of:

- 40,000 miles of airways equipped with 415 radio ranges;
- 2138 beacon lights;
- 275 intermediate landing fields;
- 133,000 miles of leased land lines for communications;
- 29 airway traffic control centers, and
- 122 airport traffic control towers.

Allowing for depreciation and obsolescence, the present appraisal value of these facilities is about $40,000,000. During the fiscal year of 1948, cost of operating this system will be about $50,000,000, or more than the total profits of domestic airlines in the past year – and a very large sum as compared with the overall loss which these lines will report in 1946.

Now the government faces large capital expen-

* Paper "Air Navigation Facilities" was presented at Metropolitan Section on Feb. 4, 1947.

ditures on the airways and even more on research to aid in developing civil aviation properly. The present radio facilities are largely obsolete, most of them having been designed 15 years ago.

Although Congress included in the CAA budget funds for replacement of the low frequency ranges with modern VHF (very high frequency) types and widespread installation of instrument landing systems and approach light lanes in the fiscal 1941 appropriations, the war came and the radio industry's entire production was consumed, and quite properly, by the armed forces.

Deliveries Are Slow

Although Congress again provided for VHF and ILS (instrument landing systems) in the 1946 budget, deliveries of equipment have only been a trickle and volume output is not expected until this month.

More than $22,000,000 is involved in this program. Proponents of this aggressive plan face two major arguments:

Surface transport interests believe that airlines are getting an unfair competitive advantage and will say that the time has come when airlines must meet all or a large part of these costs. But the fact is that this network is of enormous value to the national defense. Although 80% of use of these facilities under instrument flight rules is by air carriers, 15% by military craft, and 5% by miscellaneous civil aircraft, over the years this percentage of use by personal fliers can be expected to increase substantially.

Sees Government's Function

Secondly, the plain facts of life show that it is obviously impossible for our airlines to make a direct contribution to the cost of airways operation in view of the present state of their earnings. The surest method of improving the economic status of the industry is to provide the industry with tools to achieve increased safety and regularity of schedules.

The industry has already made great progress toward self-support. Accumulated deficits on air mail payments since 1918 have been wiped out by profits on air mail stamps during recent years. Some 165,000 people are employed on the airlines and manufacture of civil aircraft. In the year 1945 airlines paid about $20,000,000 in corporate income taxes, and transportation and air express taxes have yielded the government $20,500,000 more.

The most effective method of making civil aviation self-supporting at the earliest possible date is the acceleration of technical progress. Technical problems are navigation, communications, prevention of air collisions, and traffic control – including landing aids.

The low approach problem is one of the most important to be solved, yet is one of the most contentious of the four.

Because present day devices are not sufficiently precise, we assure safety – to quote W. E. Rhoades – "by requiring the traffic control system to apply such large tolerances in estimating plane positions and in the issuance of clearance that low traffic densities result.

"This problem is greatly intensified in congested approach areas surrounding airports where climbing, descending, and stacking of aircraft of various speeds introduce further complication. The final limiting factor is the ability of the runway to accommodate aircraft and, of course, the number of instrument runways available in any traffic area."

The solution lies in:

- Instrument approach systems at our principal airports;
- Additional instrument landing runways so equipped at large centers either through adding parallel or tangential runways at existing airports, or providing additional airports properly spaced in relation to existing facilities, and
- Control of traffic flow by the airport of destination so that volume of arriving traffic is kept within the airport's capacity.

Three Angles of Attack

We are attacking the problem from all three of these angles. The CAA-Industry program for improved instrument weather approach includes work on ILS, GCA, high intensity approach lights, and radar tower surveillance.

Due to the war emergency we have only 31 ILS installations, but expect to have 50 by spring and 100 by next summer. If our 1948 budget is approved, we expect to have funds for about 170 installations. Adoption of ILS by the Provisional International Civil Aviation Organization strengthens our conviction that the glide path type of system should be the backbone of our instrument approach for transport aircraft. It is the only known type which can be adapted to the fully automatic approaches which we and the industry believe to be the ultimate solution to low approach problems.

Systems Are Complementary

But the GCA and ILS are complementary. Hence we do not believe that both are extravagant. GCA talks to the pilot's brain through his ear instead of through his already overstrained eyes.

Important tests of high intensity approach lights are going on at Newark under a program of the Air Transport Association. Pilots and other operating personnel will be able to determine the best type of lighting best suited for air transport work.

We have asked Congressional approval for 360

ng surveillance in 25 airport towers. These will greatly assist airport and zone controllers by giving them exact information on aircraft position.

Equipping large numbers of key airports with ILS, GCA, high intensity light, and a few with FIDO (fog intensive, dispersal of) will require the substantial investment of from $20,000,000 to $40,000,000.

These funds must be largely supplied by government, and thus it is enormously important that the public realizes the implications of safety to the traveling public, to the development of civil aviation, and to our national economy and security.

Service tested technical improvements must be installed as rapidly as possible to increase the scope and accelerate the development of technical advances for the future. Foolishly rapid expenditures on unproven devices, on the other hand, produce public disillusionment and defeat this purpose.

Heron's Horning Memorial Lecture

To Appear in April's Quarterly Transactions

MUTUAL adaptation of fuels and engines to assure improved performance of aircraft can be achieved only through continued cooperative attack by competent technical representatives of aircraft powerplant, petroleum refiners, metallurgists, and other interested groups, S. D. Heron wrote in his Horning Memorial Lecture which he presented before the 1947 SAE Annual Meeting in Detroit.

The complete paper will appear in the April SAE Quarterly Transactions.

Citing the great increase in knowledge of fuel behavior in piston engines during the past 20 years, the eminent consulting engineer attributed this advance to multiphase cooperation of engine, petroleum, airline, military and other experts.

An example of the increase in power output which resulted in increased knowledge of fuel behavior during the past two decades is the 450 hp developed by the World War I Liberty engine with its 165-cu in. displacement with the Rolls-Royce Merlin's output of more than 2000 hp with the same displacement.

Specifically, preignition, fuel-air mixture distribution, and stability of stored fuels are engine-fuel problems which must be attacked soon if development of aircraft reciprocating powerplants is to continue.

Winner of the 1928 SAE Manly Memorial Medal, Heron was elected to SAE membership in 1921, has served as vice-chairman of the SAE Dayton Section, and has been active on numerous SAE technical committees in developing cooperative research projects such as those he urges be continued.

Born in England and educated at Goldsmith College of London University, the author of this Horning Memorial Lecture was on engineering staffs of Armstrong Siddeley Motors, Ltd., Royal Aircraft Factory, and the Aircraft Mfg. Co. before coming to this country in 1921 when he joined the U. S. Air Service Engineering Division, McCook Field, Dayton. He later joined Wright Aeronautical Corp, returned to the Air Corps at Wright Field, and later joined Ethyl Corp. He is a consulting engineer in the fields of fuels, engines, and engine materials.

BASED ON PAPERS* BY

John F. Korsberg Boeing Aircraft Co.
W. W. Troxell Glenn L. Martin Co.
H. C. Engel Glenn L. Martin Co.
H. B. Gibbons Chance Vought Aircraft Division, United Aircraft Corp.

Sandwich

These papers will be published in full in SAE Quarterly Transactions

SANDWICH construction – long desired by the aircraft engineer because its ideal distribution of material gives maximum stiffness and structural efficiency for a given weight – is being successfully used in such diversified applications as floor structure, panel partitioning, doors, bulkheads, and aerodynamic surfaces.

The sandwich structure consists of a face material, a core material, and an adhesive. The face material, carrying the major part of the load, is generally metal, although occasionally nonmetallic faces have proved more economical where metal was not available in thin enough sheets. Tendency in recent designs has been toward the aluminum-alloy face.

*Korsberg paper, "Philosophy for Design of Sandwich-Type Structure;" Troxell and Engel paper, "Sandwich Materials: Metal Faces Stabilized by Honeycomb Cores," and Gibbons paper, "Experiences of an Aircraft Manufacturer with Sandwich Material," were presented at SAE Annual Meeting, Detroit, Jan. 9, 1947.

So far no one core material has emerged as best. Until a synthetic is developed that has the necessary strength and stiffness, balsa wood (Fig. 1) and a honeycomb structure (Fig. 2) made of impregnated fiberglas, cotton cloth, or cellulose acetate is being used.

High-strength aluminum alloys in the form of a sponge or a small honeycomb would probably be the most desirable core material but at the present time the prospects for such a material are not bright.

The honeycomb core is superior to balsa in static strength-weight and stiffness, and since the material is a manufactured product with all its components closely controllable, the honeycomb core will provide the most consistent product.

Balsa appears to be somewhat better in resistance to fatigue and has a higher local crushing strength for loads applied perpendicular to the plane of the faces. Over a 1 sq in. area, its crushing strength is nearly twice that of the honeycomb material.

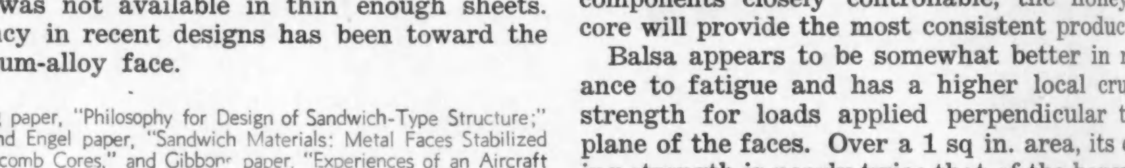


Fig. 1 – Sandwich construction consisting of aluminum-alloy faces and balsa core – metalite

Materials for Aircraft

In other words, which type of core is best for a articular application depends on the requirements o be met. For instance, in the Model 377 Strato-ruiser, both types of core material were specified:

1. Balsa was used in the floor structure, despite weight penalty of 0.2 psf, because it best met the equirements of minimum thickness, maximum atigue and wear resistance consistent with ade-uate static strength, and good resistance to local rushing and denting from the small heels of omen's shoes, and tumbling luggage and cargo.

2. Honeycomb core, metal-faced sandwich con-struction was used in the panel partitioning be-ause it best met the requirements of minimum weight with adequate strength and stiffness, since atigue loadings are relatively infrequent and of mall magnitude.

Several methods of applying the sandwich idea o wings have been developed. Metal skins are not eceptive to the double curvature that usually nters the picture, unless there is a preforming peration on the stretch press. Fabric-faced sand-wich material can be used with some sacrifice in structural efficiency. Superior performance has been attained with a wing consisting of a cellular cellulose acetate core, glass fabric skins, and glass fabric stiffeners, which is 40% lighter than the conventional aluminum-alloy skin-stiffener construction. Metal skin accurately shaped to the contour of the wing may also be used, with the core either contoured in the flat and later expanded to shape or produced by shaping the slab type of honeycomb to the contour of the wing.

As a matter of fact, the balsa core – metal face sandwich material known as metalite has been successfully applied to the major portion of the airframe of two experimental high-speed Navy fighters. For instance, 95% of the entire structure of the high-speed, jet-propelled fighter – the XF6U-1 – was made of sandwich material. The movable control surfaces were the only important items of conventional construction. In this design every effort was made to attain smooth aerody-namic surfaces. The rewards for the superlative smoothness that was attained are a very appre-ciable increase in high speed and a significant increase in radius of action, due to the lower drag, which reduces fuel consumption at cruising speed.

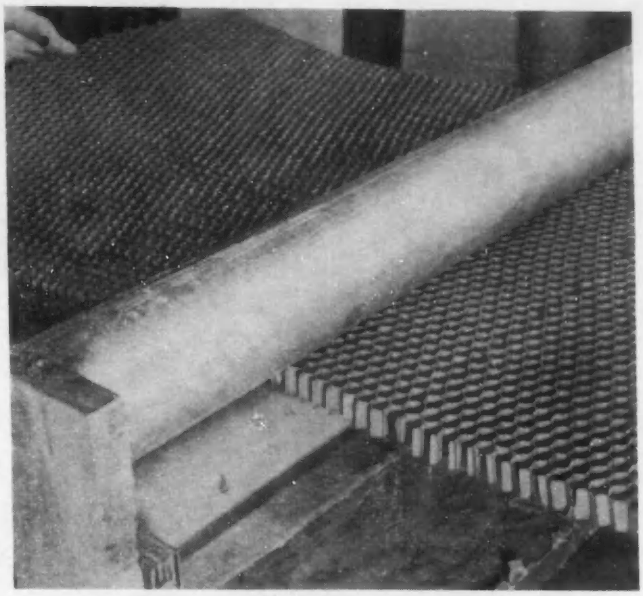


Fig. 2 – Honeycomb core being coated with adhesive

Two hundred horizontal tail surfaces for the F4U Corsair airplane have also been fabricated from metalite – a quantity sufficient to constitute a semiproduction run. Since this stabilizer was made completely interchangeable with the stand-ard, all-metal unit, it involved some compromises in design. A weight-saving of 5-10% was achieved, nevertheless, with an increase in strength of 65% in the most critical loading condition. The appear-ance and surface smoothness of the stabilizer was also greatly improved. These stabilizers are now undergoing service tests conducted by the U. S. Navy and regular production has been established.

Problems of Development

Probably the toughest engineering problem to be solved was development of suitable adhesives to bond the faces to the core. Characteristics of the adhesive determine in large measure the strength and durability of the structure. It must resist relatively high shearing, tensile, and stripping forces, and must be capable of withstanding re-peated stresses as well as sustained ones. The goal is to develop the ultimate shear strength of the core material without failing the bond. Thus, the characteristics of the core material can be matched with the design requirements to the best weight advantage. Chrysler cycleweld cement has been one of the most successful adhesives developed to date. In the metal-faced balsa-core construction the cycleweld is used as a metal-priming adhesive that is put on the metal faces and cured at a high temperature. Then the primed metal is bonded to the balsa core at a lower temperature with a thermosetting phenolic resin.

Since sandwich construction, like many manu-

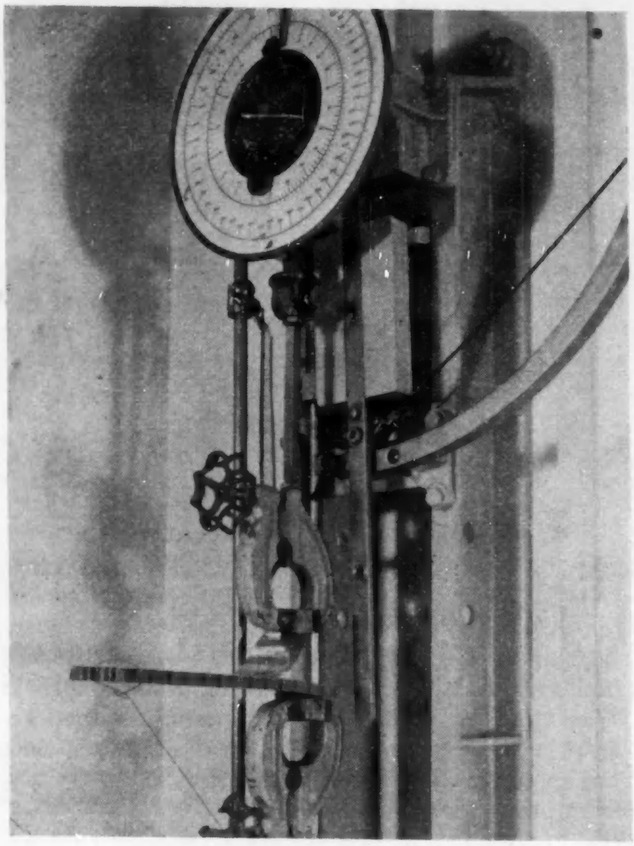


Fig. 3 – Peel test setup
Using the two faces of a sandwich specimen (3 x 12 in.), right-angle flanges (about 1 in. long) are formed for gripping in the jaws, taking care not to fail the adhesive bond locally at the heel of the formed flange. For end-grain balsa core with 0.020 and 0.016 24S-T top and bottom face panels, respectively, an average running peel force (on 3-in. wide specimen) of 35 lb is acceptable and consistently attainable under production conditions. A specimen with honeycomb core and 0.012 24S-T face panels should have an average peel force of 10 lb. Peel forces will vary with change in gage of face panels

factured products, cannot be completely evaluated by final inspection, it is extremely important to require quality control of the product at each critical step. Visual inspection and sample testing both play their parts in this process. Checking for strength consistency is a most perplexing problem, for it is a function of the uniformity and strength of the adhesive bond between face panels and core material.

Destruction tests at frequent intervals during manufacture of a given lot of material are the most reliable means of knowing that the strength of bond between face panels and core is consistent. Affidavit of the manufacturer that the material is meeting uniformly high peel strengths, plus visual examination of panels for gas pockets is a reliable assurance of quality.

The peel test carried to destruction on a Scott tester (or equivalent device) is an effective inspection method. (See Fig. 3.)

When working with large panels, one is often confronted with the necessity of making a splice to join two panels together. Since good appearance or aerodynamic smoothness will demand flush joints, the conventional butt joint with splice plates may be applied quite simply (Fig. 4A.) In many cases the splice plates can be integrally bonded to the basic face panels, providing superior joint strength, weight economy, and a saving in assembly time (Fig. 4B.) Final assembly of the joint can then be made by using a countersunk grommet and forming the driven head of the rivet into the countersunk recess, thus producing a joint flush on both sides.

Future Developments

Before the potentialities of this type of construction can be fully realized, much development work will still have to be done. Needed, for instance, is a relatively lightweight core material (10-15 lb per cu ft) with a shear strength of about 3000 psi and with sufficiently small voids to permit normal riveting methods to be used without the need for supplementary fittings.

Also needed are improved bonding materials – ones that provide greater strengths at high and low temperatures, are easier to apply, and are less critical when other process variables are not closely controlled. A single-stage adhesive would simplify the manufacture of the sandwich construction. Another need of importance is adhesives for field repair of metal-faced sandwich structures. They should provide adequate strength, and have handling characteristics suitable for use with limited repair facilities.

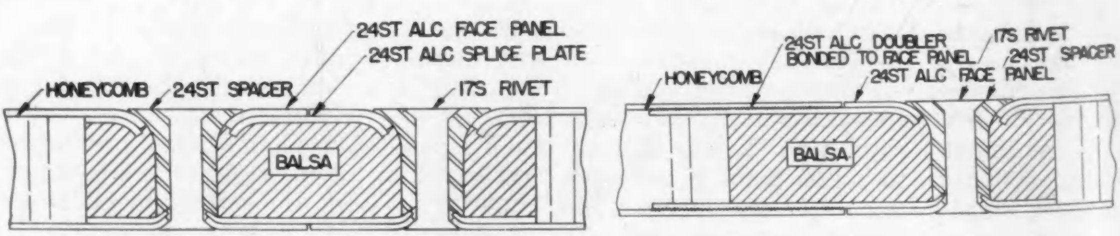


Fig. 4 – A (left): typical butt splice; B (right): typical butt splice with doubler bonded to face panel

The HOW and WHY of LIGHT WEIGHT CARS

FROM A PAPER* BY **W. D. APPEL**

Assistant to Vice-President in charge of Engineering
Willys-Overland Motors, Inc.

DESIGNING light-weight cars calls for a systematic and judicious approach to the problem in which the aesthetic takes a back seat to the functional. Many fertile weight-saving areas exist in modern American cars; the designer must put his ingenuity to work to reap the benefits of eliminating parasite weight.

Lightness in design is a triple-threat characteristic. It gives better performance; first cost is lower; operating costs are reduced.

Unnecessary material adds to the basic cost of incoming material and its transportation cost. If forgings or castings are too heavy, machining costs are excessive. If parasite weight stays with the final product, it increases the sales price, transportation costs, license or registration fees in many states, and eventually operating costs.

Before starting his weight-saving campaign, the designer must be clear in his own mind as to what is meant by a light car. It is one in which all the material has been removed from the wrong places economically, commercially, and technically and put in the right place economically, commercially, and technically.

For example, high-priced material is in the right place economically only if its use provides the necessary life factor or commercial result. If it can be replaced by lower cost materials without adversely affecting the result, then the high-priced material is in the wrong place economically.

Carried to extremes, weight-saving can jeopardize the car's commercial appeal. Leaving off an electric starter or a spare wheel would be foolish since it reduces customer acceptance and increases competition's advantage. Eliminating a pound of material from an important place will reduce life, comfort, and sales appeal of the car. But if this pound can be taken off without impairing these factors, it is justified commercially.

Technically material is properly placed when it contributes to successful operation of the mechanism. Every unnecessary pound of weight is a burden on both first cost and operating expense. It can take the form of an unnecessary number of cylinders, luxury gadgets, and excessive ribbing on castings.

Tackling the problem in this country, we must set our sights on a vehicle that is not so small and

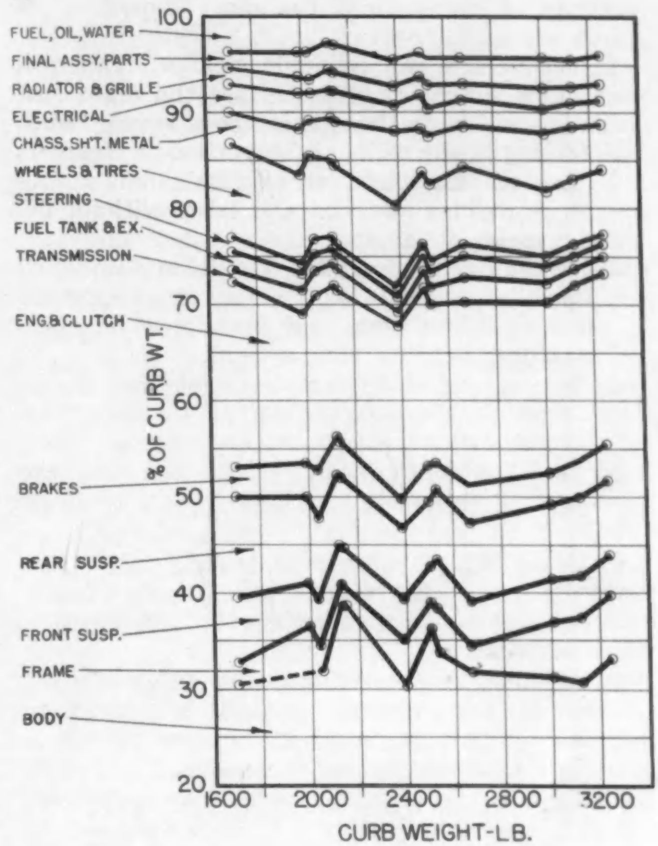


Fig. 1 – This chart shows how weight of production cars of American, English, and German design distributed percentagewise among the vehicle functional groups

*Paper "How Light is Light in the Passenger Car Field?" was presented at SAE Annual Meeting, Detroit, on Jan. 8, 1947.

uncomfortable to invite ridicule. If possible, it should appear and perform just like the cars we're accustomed to driving.

There is no particular magic in making a car light. It can be done by leaving off things and by using thinner sections. But it takes real technique to make the car light and at the same time acceptable in appearance, retaining proper performance, satisfactory road-handling characteristics, and adequate durability.

It's a painstaking job of studying each vehicle group – such as body, engine, frame, and tires and wheels – to ferret out hidden parasite weight and cost and then removing them. There are several methods of doing this, the most important of which are as follows:

1. The vehicle can be made smaller. This will save more weight than cost since the main cost reduction will be in the raw material saved. Labor and tooling costs will not be seriously changed.

2. Unnecessary parts can be eliminated, saving weight as well as material and labor without decreasing commercial appeal.

3. Design can be simplified to eliminate unnecessary machining operations. This is more important in reducing labor costs and investment in tools and machinery rather than weight.

4. Several functions can be combined into a single part. An example of this is the combination rear trunk lid handle, lock, and license plate lamp used on some cars. Weight and cost are reduced and commercial acceptance may even be enhanced.

5. Using higher stresses is good practice provided they are kept within safe limits. Weight and material can be saved without affecting other characteristics.

6. Use of light metal alloys, the most publicized solution to the problem, reduces weight at an increase in material cost. It is most useful in building revenue-producing vehicles such as trucks and buses; but in privately owned passenger cars the increased cost rarely can be amortized by additional economy of operation.

In tackling design for light weight, maximum use of brains will make for minimum use of material and muscle. Putting the brains to work is worthwhile because they are used only once – during the designing and tooling stages; but material and muscle go into each vehicle from the moment fabrication of its first part starts.

Reap Savings in Body

Weight must be taken out of all possible units. Ounces must be eliminated from light parts, pounds from heavy parts. Most potential savings lie in the body because it is the heaviest single unit and a relatively low stressed structure. It contains a high percentage of nonstructural trim and garnishing.

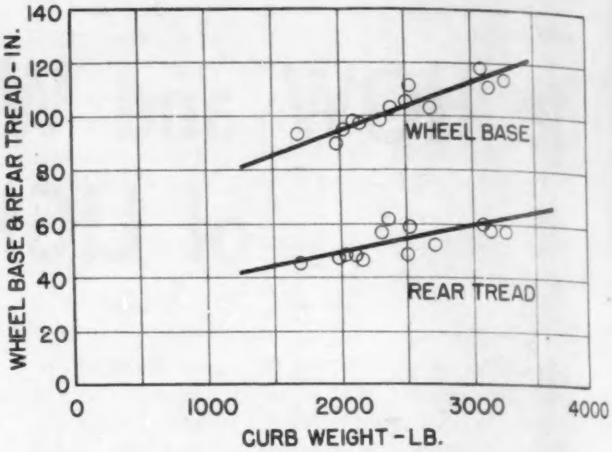


Fig. 2 – Plotting wheel base and rear tread against the curb weight of 13 American and foreign cars discloses that the lighter car is a smaller car

Every pound of nonstructural or parasite weight removed from the body will allow a weight reduction in those units that support the body and start, stop, and steer the vehicle.

After having trimmed the overall car design to what he considers is as close to the optimum as possible, the designer should determine to what degree he has achieved the objective of a truly light-weight car. The pattern of previous designs stand out as a useful tool for gaging relative merit.

Such an analysis was made of design trends in 13 American, English, and German cars, bringing to light some interesting relationships.

Note Weight by Function

Plotting the percentage weights of the various functional groups of each car against the curb weight of these cars produces the curves in Fig. 1. It is remarkable that group percentage curves are fairly flat and horizontal (neglecting individual design fluctuations), indicating that functional groups in the smallest car utilize about the same percentage of total weight as those of cars weighing nearly twice as much.

Two main exceptions are the frame group, which increases percentagewise as the cars get heavier, and the wheel and tire group, which decreases slightly with an increase in car weight.

The three highest points in the body group are English cars in which leather trim, bucket seats, sliding roofs, and other equipment add to the body weight. This makes for a proportionately smaller weight percentage for the other groups, as noted on the chart.

Closer examination of these cars will show a definite relationship between curb weight and car size. Wheelbase and rear tread plotted against curb weight of these cars, Fig. 2, is a fairly good yardstick of car size, particularly with cars of

similar design. There is no mistaking that a lighter car is smaller than a heavier one.

There also is a definite relationship between car weight and potentional performance. This can best be illustrated by comparing car curb weight plus a simulated 450-lb passenger load against engine displacement as potential performance, shown in Fig. 3.

This relationship reveals that engine size shrinks faster than car weight. In other words, fuel economy as well as lower performance are characteristic of low-cost vehicles.

Fig. 1 showed that although the weight percentagewise of various functional groups fluctuated, their average is fairly uniform over the entire range. Apparently some designers do a better job of utilizing materials than others. But weight alone is not a true yardstick for measuring

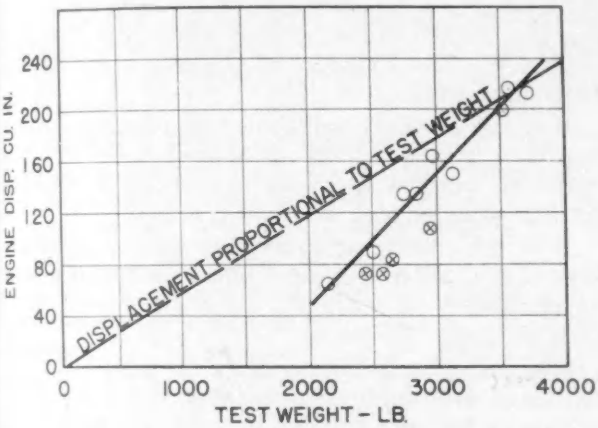


Fig. 3 – Engine size decreases faster than car weight in the 13 cars analyzed. The crossed circles represent English designs in which the taxation formula had a further dominating influence on engine size

design effectiveness; it must be judged in relation to the function performed.

Obviously an engine of large displacement will weigh more than a smaller one. But comparing them on a weight-per-cubic-inch basis offers a gage for determining the design which achieves the best result for the least weight. Other groups can be evaluated in the same way so that the designer can find how well he has performed or which standard he must reach to meet a definite weight objective.

Examination of some of the principal groups will indicate both how close and how far many come from hitting the best result obtained.

How body weight varies with curb weight is shown in Fig. 4. Bodies mounted on conventional frames are indicated by solid dots; circles represent bodies of frameless car construction. Triangles indicate English all-steel bodies of frameless construction embodying the greater luxury demanded by the English market.

English bodies weigh about 150 lb more than those of American design in cars of the same curb weight. Complete bodies on Engish cars constitute about 37.5% of car curb weight; the American type body represents only 31.5%. Therefore, the complete body of a 2000-lb American car should weigh 630 lb.

Before leaving the subject of bodies, it should be noted that relationship between body roominess and body weight is a most important consideration. The designer offering the most in interior comfort and roominess at the lowest weight and cost is doing the best job. But arriving at a measure of roominess is not easy. Linear dimensions and even volume of space fall short of adequately expressing roominess.

Penalty of Ornamentation

But this is apparent. For a car of a certain curb weight, a definite number of pounds are allocated to the body. Using this weight for heavy gage metal, four doors, thick seat backs, and lavish hardware and interior fittings will result in a smaller interior space than if the same weight of materials were used to build a simple two-door vehicle without frills, the extra weight going into construction of a roomier body shell.

In Fig. 5 the weight of the frame group is plotted against curb weight. It shows that the percentage of total weight required for the frame is less with lighter than with heavier cars. Partial frames weigh about half as much as full frames, this being the limit in weight-saving with frameless construction. It adds up to about 45 lb in a 2000-lb car and 100 lb in a 3000-lb car.

This feature alone will not make a car light; but it can be a potent factor in the designer's bag of tricks.

A field ripe for design variations, in which the pickings are good for designers bent on weight-saving, is the engine group shown in Fig. 6. Com-

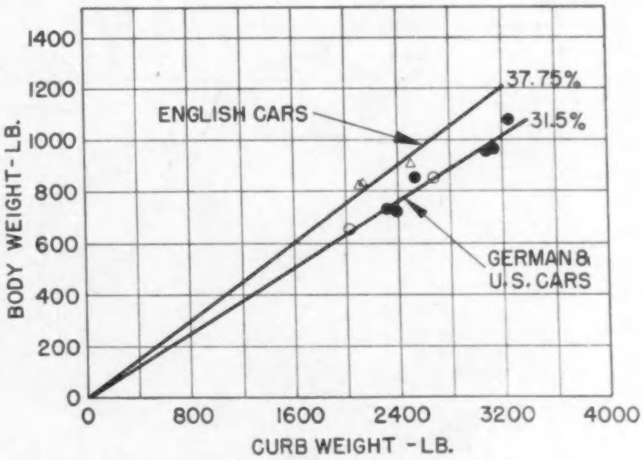


Fig. 4 – A study of body weight shows that English bodies, indicated by the triangles, are comparatively heavier than those in American and German cars because of additional equipment such as leather trim, bucket seats, and sliding roofs demanded by the English market

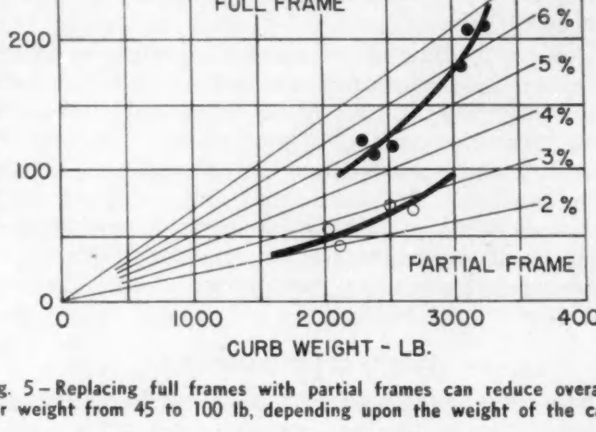


Fig. 5 – Replacing full frames with partial frames can reduce overall car weight from 45 to 100 lb, depending upon the weight of the car

monly accepted variables in conventional engine design are number of cylinders, L-head versus overhead valves, and bore-stroke ratio. A fourth factor from a weight-efficiency standpoint is the practice of offering the several engines of the same basic design, but differing in bore or stroke or both – in effect overboring one engine to produce a series of engines.

But actually there is no such thing as overboring, and here is why:

The engine of largest displacement must be just as satisfactory as its cousin with the smaller displacement. Getting more cubic inches in this way adds practically no weight to the engine; so boring an engine to its maximum displacement gives the lowest weight per cubic inch. Actually

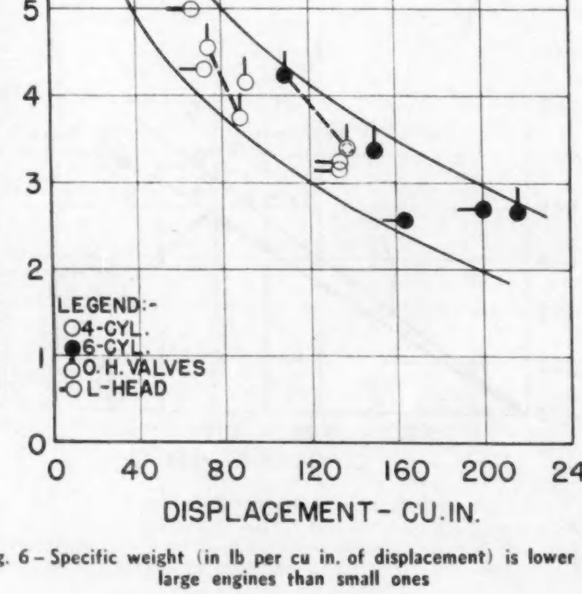


Fig. 6 – Specific weight (in lb per cu in. of displacement) is lower for large engines than small ones

this amounts to developing the lightest engine for a given displacement and providing other models by underboring, rather than underboring a smaller engine to increase the displacement.

This penalizes the smaller displacement and usually cheaper unit with unnecessary weight.

Since we observed in Fig. 3 that engine displacement is not proportional to car weight, but less for lighter cars than for heavier ones, smaller engines will weigh more per cubic inch than large ones. This is logical since casting and forging thicknesses are established by forge shop and foundry practice. This causes an unfavorable power-weight relationship for small engines.

Engine Types Compared

Fig. 6 charts weight per cubic inch against displacement for engines in the cars being discussed. Hollow circles represent 4-cyl engines; solid dots are the 6-cyl designs; a dash above the circle indicates overhead valves; at the side it indicates a side-valve engine.

Because of the conditions just discussed, these points fall in a hyperbolic-shaped zone with the heaviest engines near the upper limit and the lighter designs near the lower limit.

It is interesting to note that 4-cyl engines are used for smaller displacements, up to about 135 cu in., and 6-cyl engines overlap the fours, beginning at about 108 cu in.

While overhead-valve engines are near the upper limit and side-valve engines near the lower limit, difference between the two is not nearly so marked as expected. Examples of side-valve designs near the upper limit and overhead-valve designs near the lower one demonstrate that weight of an engine type can be appreciably influenced by design details.

Underboring Costly

Examples of underboring practice are the two engines connected by dotted lines. Underboring the 4-cyl 88-cu in. engine to 73.4 cu in. increased its specific weight from 3.75 to 4.56 lb per cu in. If the lightest engine of 73.4-cu in. displacement had been built for about 4.0 lb per cu in., about 41 lb of weight could have been saved. The same holds true in the case of the two sixes.

An analysis similar to these could be made for other functional groups such as suspensions, wheels and tires, and transmissions shown in Fig. 1.

But again it is emphasized that these studies are not to be taken as indices of design merit. The graphs should be considered as having been prepared with broad brush strokes rather than a sharp-pointed pencil to establish a reference based on existing practice – where durability and service records are known quantities.

Rating Fuels with Knockometer

BASED ON A PAPER* BY

P. J. Costa and J. W. Wheeler

ENGINEERING DIVISION,
SPERRY GYROSCOPE CO., INC.

THE knockometer is an electronic instrument for rating the detonation qualities of a fuel free from engine and other background noises and differences in operators. It meets the major requirements for knock instrumentation – accuracy, dependability, convenience, and production of results which are reproducible.

The knockometer, like the doctor's stethoscope, amplifies certain selected vibrations so they can be observed and studied. It operates as follows:

1. A vibration pickup (Fig. 1) attached to the exterior of the cylinder head transforms the cylinder-head vibrations into electrical impulses.

2. Unwanted vibrations are eliminated by means of a commutator, which selects the pickup output voltage caused by combustion vibrations only.

3. The pickup output is amplified to a level suitable for use with the indicator desired.

Two models of knockometer have been developed. The KM-1 was designed for use in conjunction with the CFR-F-4 supercharge test procedure for determining the knock characteristics of aviation fuels. It has been approved by CRC for use with this procedure. The KM-3 was developed to take the place of the bouncing pin used with the CFR-EF-2 motor test procedure for determining knock characteristics of automotive fuels.

KM-1 Knockometer

The KM-1 indicates knock by an instantaneous flash on a neon indicator, while a quantitative measurement is registered on a meter. (See Fig. 2.)

In rating a fuel by the F-4 procedure, the fuel-air ratio versus knock-limited indicated mean effective pressure curve for the unkown fuel is determined and plotted, along with similar plots for two or more reference fuels – at least one hav-

* Paper "The Knockometer – A New Instrument for Fuel Rating," was presented at the SAE National Fuels & Lubricants Meeting, Tulsa, Nov. 7, 1946.

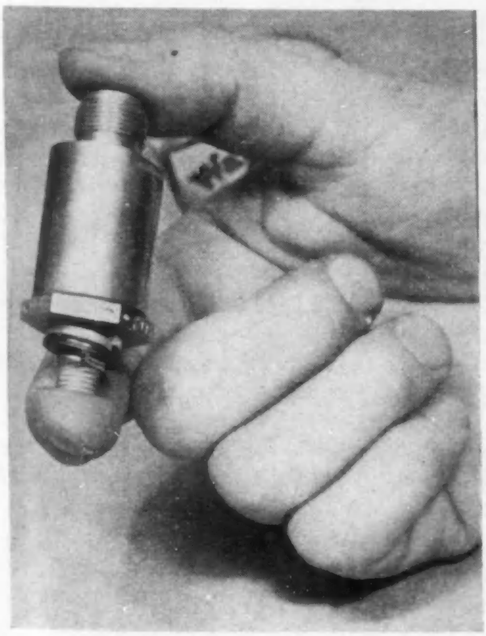


Fig. 1 – Detonation pickup

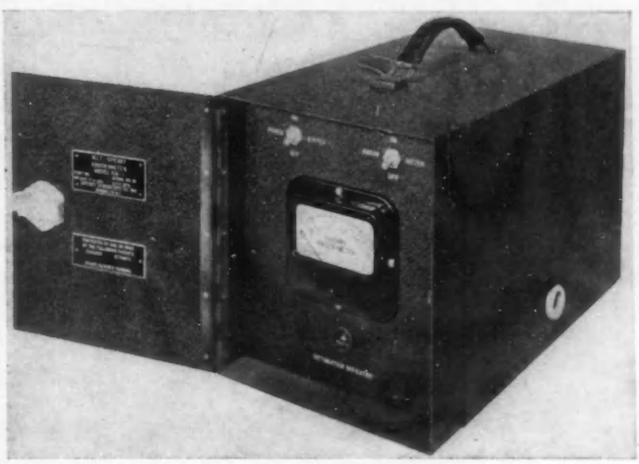


Fig. 2 – KM-1 knockometer

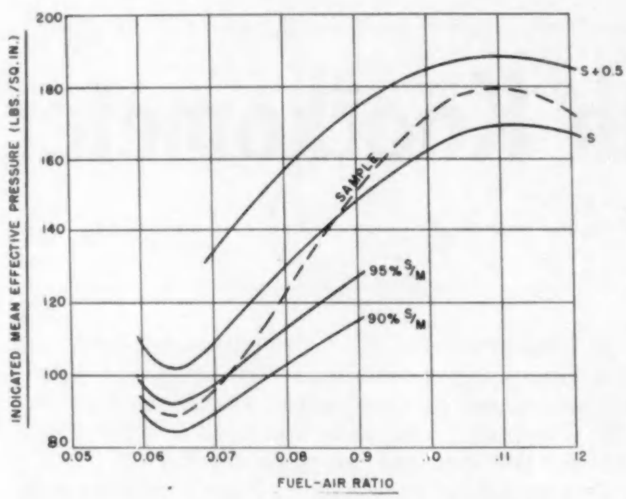


Fig. 3 – Plot used to rate a fuel by CFR supercharge procedure F-4

ing a rating above and at least one having a rating below that of the unkown fuel. The octane rating of the unknown fuel is then determined by the relationship of the curve of the sample with the curves of the reference fuels. (See Fig. 3.)

To avoid errors in octane ratings, the standard knock limit must be detected accurately. So, the knockometer has been designed to be very sensitive to changes in knock level – to act, in effect, like a go-no-go gage. This requirement is accomplished by making the instrument reading change rapidly with increasing manifold pressure, once detonation is encountered.

Reproducibility was attained by removing all controls and making the instrument operate automatically by means of an automatic gain control and a knock differentiating circuit. As a result, the instrument is able to adjust itself for existing engine conditions, it "recognizes" the difference between normal combustion and knock, and it continuously recalibrates itself with age.

Since there are no controls to adjust, an inexperienced operator cannot make it register knock falsely. If no knock is present, the meter simply does not register.

Automatic Gain Control – Automatic gain control is necessary because detonation vibration amplitude is proportional to the amplitude of the normal combustion vibration, which in turn varies with changes in engine conditions. Thus, at low power the amplitude of detonation vibrations is two or three times that of the combustion vibrations. At high power, the combustion vibration amplitude is much larger, but the detonation vibration has also increased, so that it is still two or three times that of the normal combustion vibration. If only a fixed gain amplifier were used, adjustments made at high power would make the instrument appear insensitive when the engine was operated at low power, because it would require a considerably heavier detonation to operate the indicator. On the other hand, if the amplifier were adjusted for low power, the meter would appear too sensitive at high power, so that it would give false indications of knock. (See Fig. 4.)

The automatic gain control, however, electronically amplifies all vibrations automatically to a standard height or reference level. The amplified output is applied to one of the tubes in such a way that when there are no vibrations the amplifier gain is maximum. When vibrations are amplified, the resulting output voltage is used to reduce the gain of the amplifier just as though the gain control were adjusted manually. Therefore, if the vibrations should decrease, there would be less control voltage applied to this tube and the amplifier gain would increase until the desired reference level is again attained.

Knock Discriminating Circuit – A knock discriminating circuit is used in conjunction with the automatic gain control to discriminate between

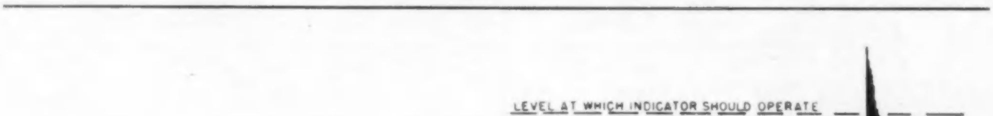


Fig. 4 – Theory of detonation amplifier with automatic gain control

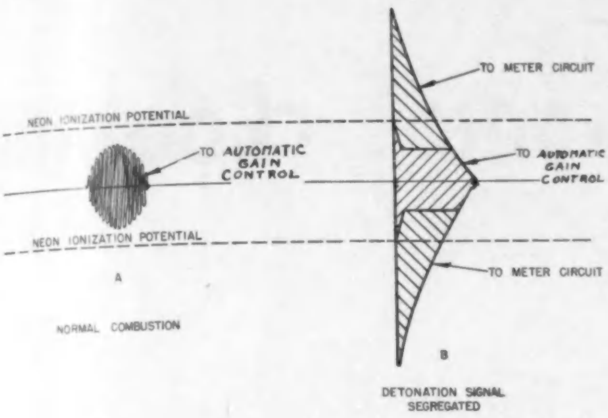


Fig. 5 – Theory of detonation discriminating circuit

normal combustion and knock. Otherwise, the large signals from continuous knock would finally reduce the amplifier gain to a point where the meter would not read at all for any intensity of knock. (See Fig. 5.)

In a properly operating engine, normal combustion varies in amplitude 20-50% from cycle to cycle, depending on variations in such factors as ignition, fuel distribution, and scavenging. Detonation, however, produces a large, spontaneous vibration at least 200% of normal combustion vibration at the threshold, and it may even exceed normal combustion vibration by 10 to 20 times under more severe conditions. It occurs from one to five times a minute at the threshold, and almost once every cycle at the more severe conditions.

This characteristic of knock is used to make the instrument clip off the knock signal and prevent it from adversely affecting the automatic gain control circuit.

This is done by selecting a neon tube with a suitable ionization potential, and by using this ionization potential as a reference level, any voltage above this predetermined value is cut off.

Other Operating Features – The meter does all the mental integration that otherwise would be required of the operator. By means of its integrating circuit, it indicates a value proportional to both the intensity and frequency of occurrence of knock over a period of time – a very important factor since engine damage is a function of both.

False meter reading due to engine malfunctioning is unlikely, for when the engine is operating improperly, the meter usually goes off scale or becomes so insensitive to small changes in manifold pressure that fuel rating must be stopped.

KM-3 Knockometer

In developing the KM-3 knockometer (Fig. 6), the same basic operating principles were used as in the KM-1, except that the automatic gain control was omitted, because of the differences in knock level between the EF-2 and F-4 procedures.

The EF-2 procedure differs from the F-4 in that compression ratio is varied instead of manifold pressure. Since octane number producing standard knock varies with compression ratio, the unknown fuel is run in the CFR test engine at increasing compression ratio until a point is reached at which the bouncing-pin-knockometer combination reads approximately 55 with the carburetor adjusted to give maximum knock. Then, with the compression ratio held at this point, reference fuels are run in the engine until two are found that give readings approximately the same as the unknown fuel, but one must be slightly higher and the other slightly lower than that of the unknown fuel.

The octane rating of the unknown fuel is then determined by assuming the rating is in the same proportion as the knockometer readings. For example, if two reference fuels of 74 and 76 octane number give knock readings of 60 and 40, respectively, and the unknown fuel reads 50, the rating of the unknown fuel would be midway between the two reference fuels, or 75 octane.

Omission of the automatic gain control, as well as the addition of a less sensitive but more stable meter circuit (necessary for the EF-2 method) made line voltage regulation necessary.

Generally, the KM-3 knockometer is about twice as sensitive and a little less steady than the bouncing pin. As knock increases in intensity, both stability and sensitivity of the meter increase, even at intensities many times heavier than standard knock. At very heavy knock, however, stability continues to improve, but sensitivity begins to fall off, making reproduction of data difficult.

Sensitivity is affected by both fuel blends and

concluded on page 37

Fig. 6 – KM-3 knockometer

Looking Ah

In this article, Colwell and Taub crystallize the thinking of over 60 leading engineers on the trend in vehicle engine design.

They report that gradual, not radical changes will dominate development toward higher economy and performance and that this metamorphosis will take the form of refinements in today's combustion chambers.

Highlighted are relative merits of valve-in-head, L-head, and F-head engines; anticipated increases in compression ratios; justification for supercharging and fuel injection.

(This paper will be published in full in SAE Quarterly Transactions)

INTEREST in more output derives from the fact that most operators hold that trucks and buses are under-powered today (due perhaps to excessive overloading of the vehicles). Economy has always been important. Higher-octane fuel would allow the designer to increase both output and economy, which leads to interest in future combustion-chamber trend.

Compression ratios will increase gradually, based on the premise of better fuel. This will call for detailed study of combustion-chamber refinements to prevent detonation, with particular attention to cooling; and for engine redesign to obtain rigidity for shock control.

The trend toward some type of valve-in-head design is predicted. The elimination, or at least reduction of combustion-chamber deposits will receive more attention as compression increases. Some means will be found to do this. Better piston rings, close-fitting pistons, cooled valves, and better sparkplugs adequately cooled will be used.

Design Refinement Research

Predetermination of combustion roughness by the plaster-cast method will be more important, and the study of crankshaft vibration may shed light on chamber design. Many refinements well known, but not generally used because of cost, will be necessary with high compression.

For the long trend, supercharging will be thoroughly investigated. Valve-in-head is favored for this design, but work will also be done on L-heads, and on opposed engines using both designs.

*Paper "The Trend in Combustion Chambers and Fuel Systems," was presented at SAE Annual Meeting, Detroit, on Jan. 7, 1947.

Pressure carburetion will be widely studied, with problems to be solved in fuel pressure, distribution and calibration. It will likely be the next step in fuel systems, with a positive displacement or centrifugal pump in or near the fuel tank.

Fuel injection holds interest for the long trend, but must be moderately priced, simple, and ser-

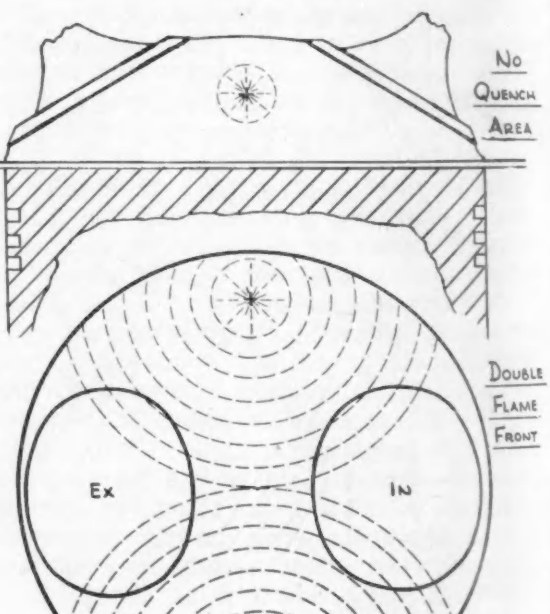


Fig. 1 – A penthouse-type chamber with standard spark-plug positioning and with no quench area is some 15 times rougher than passenger car or truck engines. Now look at Fig. 2

Ahead to Tomorrow's Engines

EXCERPTS FROM A PAPER* BY

A. T. Colwell Vice-President, Thompson Products, Inc.

and Alex Taub Consulting Engineer

viceable in the field. It offers certain definite advantages and also some problems to be solved. There is no system today for ground vehicles meeting these requirements.

In general, combustion-chamber trend will be dictated by fuel available, the method used to increase output, method of power transmission, and fuel system, together with satisfactory components for higher output. The trend in any chosen type will likely be refinements of existing chamber design.

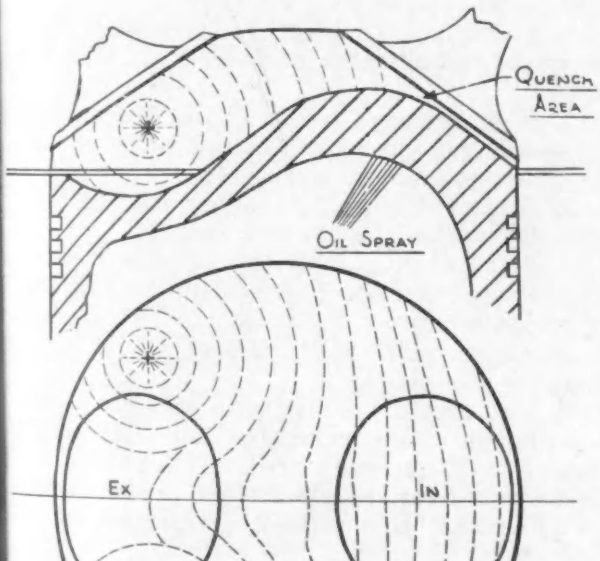


Fig. 2 – This suggested hemispherical chamber design, with two spark plugs near the exhaust valves and a good quench area at the intake, should give better shock and detonation control

Points of general agreement today are as follows:

1. As fuel improves in octane number, and is satisfactory, compression ratios will gradually increase up to about 8:1 for small engines and about 7:1 for large engines for the near future (Bartholomew indicates regular fuel of 80 and premium of 86, Motor Method, by 1950).

Many engineers stress the troublesome and unexplained phenomenon of excessive varnish deposits by some fuels in intake manifolds and on intake valves, causing intake-valve burning. It was troublesome last winter, generally disappeared during summer, and a few now report it as reappearing. Some hold the opinion that unless this condition is corrected, it will retard the progress of higher-octane fuel. It does not occur with straight-run gasoline, and is apparently a function of temperature and certain fuels.

2. Compression ratios will be resolved on an economic basis: ton miles per dollar per hour, *not* miles per gallon.

3. Reliability and longevity will be the first requirements of truck and bus engine-design, getting all the specific output practicable over long and often continuous operation.

4. Combustion-chamber work is more development than design – more of an "art" than a "science" – art being knowledge made efficient by skill, whereas science is systematized knowledge.

5. Physical limitations are governing factors in combustion-chamber design – all designs are a compromise.

6. The road to higher compression is not easy – many factors are involved; better rings, bear-

ings, cooling of exhaust valves and sparkplugs, better gaskets, attention to cylinder-head studding, close-fitting pistons, improved induction, and generally heavier design in the lower part of the engine.

7. With higher compression ratios, particularly with small combustion-chamber clearance, accurate processes for holding dimensions will be essential.

8. Combustion-chamber deposits will be more troublesome with higher compression. Some methods should be employed to lower both the quantity and density of these deposits (octane requirement changes upward with deposits, in many cases more than 10 octane numbers, with loss in power of 15% or more).

9. Surface-to-volume ratio definitely ties in with efficiency.

10. Raising compression pressure through supercharging holds considerable interest, pointing toward higher compression *pressures* instead of higher compression *ratio*.

11. Operating cost, not necessarily first cost, will govern. Many things which may add to first cost will prove their worth; down time for repairs is important to fleet operators.

12. Proper combustion-chamber and general cylinder cooling may accomplish more than combustion-chamber design. Cooling was universally emphasized. The prevention of local hot spots (cooling for detonation control) will not prevent shock.

13. Some form of valve-in-head design is generally predicted with higher compression, but not by all engineers. Cylinder breathing was emphasized as pointing away from the L head.

14. A simple fuel injection system at affordable cost, serviceable by field mechanics, would find wide and immediate use.

15. There is interest in pressure carburetors.

16. There is no ideal sparkplug location for all engines, the location usually being determined by test; with higher compression, the location and cooling will be increasingly important, but in general a location near the exhaust valve is favored.

17. Compression ratio is a curve of diminishing returns, but with decided advantage at low load factor.

18. There are four major means of getting additional power for trucks and buses: (1) increasing compression ratio and volumetric efficiency; (2) a larger engine; (3) using two engines; (4) supercharging.

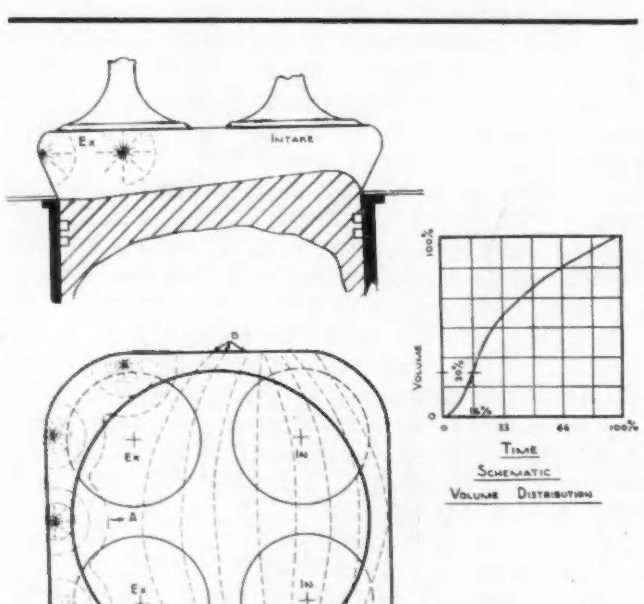


Fig. 3 – Proposed here is a pancake combustion chamber – for aircraft engines – that should warm the hearts of spark-plug manufacturers. Advantage of this multiple-plug design is a low shock factor and suppression of detonation

Future Design

Basis of future trend will probably be found in some one of the present-day designs – valve-in-head, L-head, and F-head – with refinements in cooling, induction and exhaust system, piston design, internally cooled valves, better spark plugs, and other details. The amount of change will depend on the fuel available, the method of transmitting power, the method decided upon for increasing output, and the cost.

Valve-in-head Analyzed

A valve-in-head design offers:

1. Freedom from breathing resistance existing in an L-head chamber just above the edge of the bore;

2. High degree of freedom from existing shapes to which the L-head is confined, more important as compression ratio increases;

3. Greater liberty in shaping the combustion chamber within the physical spaces;

4. Removal of highly heat-stressed elements from the cylinder block; divides thermal and structural loads between head and block; confines any heat failures to the head; and offers a considerable foundry advantage;

5. Less sensitive to deposits than the L-head.

Although more expensive and likely to be noisier, it is generally predicted that some form of valve-in-head design will be predominant. It could present a dimension problem in opposed engines.

L-head Engine Pros and Cons

Many engineers rule the L-head out for the future with compression ratios above 8:1, but many do not. (Paradoxically, the general opinion is that compression ratio is not going above 8:1 in larger engines, slightly over 7:1 being predicted.) Simplicity and low cost are greatly in its favor. Changing would mean tremendous production revisions where L-head is now used, and a small

gain in output might not be worth the cost. The L-head is more sensitive to fuels and deposits.

In one test with the same cylinder and valves, an L-head breathed as well or slightly better than a penthouse design; but the latter gave better output, using the air more efficiently. Surface volume ratio and specific air consumption are definitely linked.

Regarding compression ratio, many engineers believe increase will be slower than anticipated. One reason given is the intake valve and manifold varnish problem. Also, at a ratio of 8.5:1, explosion pressures are of the order of 1,000 psi, compared with about 600 psi at 6:1. This calls for rigidity, redesign for shock, attention to blowby on pistons and rings, attention to bearings, and accurate chamber machining.

It will require better rings and close-fitting pistons. Deposits rapidly change octane requirement. Better sparkplugs adequately cooled, with increased voltage, will be necessary, with much attention paid to volumetric efficiency. Engines must operate on fuel the driver is likely to use, not on the best he can get.

Compression ratio is a curve of diminishing returns, but valuable at low load-factor. Considering all the data, weighted opinion is that some type of overhead-valve arrangement will be more widely used, but that L-head engines will remain for a considerable time. Compression pressure through supercharging could change the trend of compression ratio.

The F-head Engine

The F-head is old, but has been adopted by Rolls-Royce in the latest Bentley. It offers rigidity, combustion control, volumetric efficiency, and good cooling. A large intake valve can be located over the bore. It lends itself to the use of an aluminum head, and offers maximum valve size and cooling for combustion-chamber size. With 6.5:1 ratio, this engine delivers 135 to 140 bmep. An aluminum head could possibly raise this to 7.5:1.

Many engineers favor the F-head, while the majority feel that the conventional in-line valve-in-head offers a better production set-up, giving almost as good performance, with servicing simpler. The F-design is good for antishock and antiknock.

Proposed Designs

Fig. 1 and 2 are diagrams of penthouse type chambers showing in Fig. 1 the standard position of the sparkplugs and the resulting progression of flame front, with no quench area or equivalent. Fig. 2 is a suggested design, using the piston head to control flame front, with good quench area at the intake valve, which should be better for shock and detonation control.

Fig. 3 is a suggested aircraft design indicating the theoretical advantage of multiple plugs. Firing is from the hot to the cold area, with flame-front area a maximum when 16% of the distance has been traveled and 20% of the volume burned. From that point on, rate of pressure rise should fall, giving a low shock factor; and by bringing the piston head close to the intake valve, detonation should be suppressed. (Sparkplug manufacturers would no doubt favor this design.)

Supercharging focuses attention on compression pressure rather than on compression ratio, and there is long-range interest in its possibilities. A turbo-supercharger would give flexibility, allowing the engine to work at higher load-factor. There are many design problems involved in supercharging, but great interest is shown in its possibilities.

Superchargers should give greatest advantage with valve-in-head engines. Detonation with supercharging does not increase at the same rate as with compression ratio, and for the same power increase there will be less shock.

Sparkplug location in any head will be limited by the type of head, compression ratio and pressure, timing and possibly other factors. The position will in general favor the exhaust valve.

Fuel Systems

There is interest in fuel-pump location in or near the tank. Such an arrangement should tend to correct vapor lock by putting pressure in the line. Aircraft use booster pumps at or in the tank very successfully. Higher pump pressure (about 10 psi) is necessary for ground-vehicle pressure-carburetors, which should give better atomization and distribution.

Looking further ahead, fuel injection is of great interest if a satisfactory, simple, moderate-cost unit can be found.

It will be necessary to prove on any given engine that injection will improve distribution, permit higher output, and improve economy. In this connection, it would be desirable to hold production tolerances on carburetors and distributors to closer limits. Carburetor tolerance is about $\pm 3\%$ on either side of the required curve, and distributor tolerance about ± 2 flywheel deg.

In certain cab-over-engine designs, fuel injection might show sufficient advantage when the carburetor is located a relatively long distance from the inlet ports to justify its cost. Crankcase ventilation apparently will be more important with fuel injection.

For export vehicles, engineers must know what types of fuel are likely to be used and design accordingly.

Injection to individual cylinders gives cold full-throttle, which is good, but also cold part-throttle, which is not good. The present carburetor covers a number of mixture ratios from zero starting to full throttle, and air distribution will still be important with fuel injection. A step between the present carburetor and fuel injection could likely be a pressure carburetor, which will present some interesting problems in metering and calibration.

Skinner Slide-Valve Engine Boasts

THE slide-valve engine is described by Skinner as a high power producer in a small package that is less expensive to both build and operate and that will outperform conventional poppet-valve powerplants. Cars and trucks powered by this engine, he states, can be lighter in weight and more economical in price as well as operation. He says that:

Major advantage of this nonpoppet configuration is the absence of the hot exhaust valve. From this feature follow a number of important improvements.

A hot exhaust valve acts as a hot spot that may initiate combustion before regular ignition of the flame front. This induces harshness and sometimes valve burning.

In the slide-valve engine all possible hot spots are eliminated. It has actually performed – under operating conditions – without detonation at compression ratios $1\frac{1}{2}$ to 2 times higher than those of a poppet-valve engine of the same displacement.

The high volumetric and mechanical efficiency inherent in the engine results in higher horsepower-weight ratio. Engineers have estimated that a ratio of 1 hp to 4 lb of engine weight is possible with the Skinner engine. They feel that cars powered by it can be lightened by as much as 800 lb.

Another fertile area visualized for this engine is the large truck and bus field, where higher horsepowers are needed and engine life and economy are of prime import. Taking full advantage of the slide-valve construction and using aluminum generously, it is conceivable that as much as 1200 lb could be saved on a 3000-hp engine.

Using higher compression ratios would produce much greater economies than are available with any engine now in production. Fleet operators are after better acceleration and faster schedules and they have turned to increased power as the means to this end. In the slide-valve engine they will find the answer to more horsepower without increasing engine size or vehicle weight.

Other features of the slide-valve design are worth noting.

Valve troubles common in poppet designs are conspicuously absent in the Skinner engine. Valve operation is quiet . . . positive valve control eliminates troublesome cams and springs . . . by the same token valve adjustments and automatic valve clearance takeup mechanisms are no longer needed . . . valves never stick.

Combustion chamber design is compact so that exposed area is kept to a minimum. Ample valve opening area permits adequate breathing without affecting cylinder spacing or combustion chamber design.

The engine lends itself to use of light metals for cylinder block and crankcase. Replaceable hardened cylinder liners of any material can be

*Paper "The Development of the Skinner Slide-Valve Engine," was presented at SAE Annual Meeting, Detroit, on Jan. 7, 1947.

CONSTRUCTION

The piston assembly operates in a floating liner or inner cylinder, (1), supported at the lower end of the cylinder bore. An annular space of 0.040 to 0.050 in. between the outside of the inner cylinder and the bore of the cylinder block accommodates the two semicircular slide valves – (2), the exhaust valve and (3), the intake valve. A small crankshaft and connecting rod assembly reciprocates the slide valves.

Upper end of each valve is provided with a port that registers with a port, (4), in the cylinder block when the valve is substantially at the center of its travel.

A port ring, (5), located on top of the inner cylinder seals the two gaps where the two valves meet. The port ring inlet and exhaust ports are in register with the cylinder block ports.

The cylinder head, (6), is a casting or stamping on which a series of thin laminated, flexible steel reeds, (7), are secured. Outer diameters of these reeds are ground concentric with the cylinder head. The reeds are embraced by an L-shaped sealing ring, (8), the wider face of which is about the same width as the port ring thickness.

With the cylinder head assembled in its place, the Belleville spring washer, which contacts the other face of the sealing ring, exerts a 400-lb pressure against it; the ring in turn passes this load to the inner cylinder by transmitting it through the port ring.

Unusual Economy

FROM A PAPER* BY

Ralph L. Skinner

PRESIDENT, SKINNER MOTORS, INC.

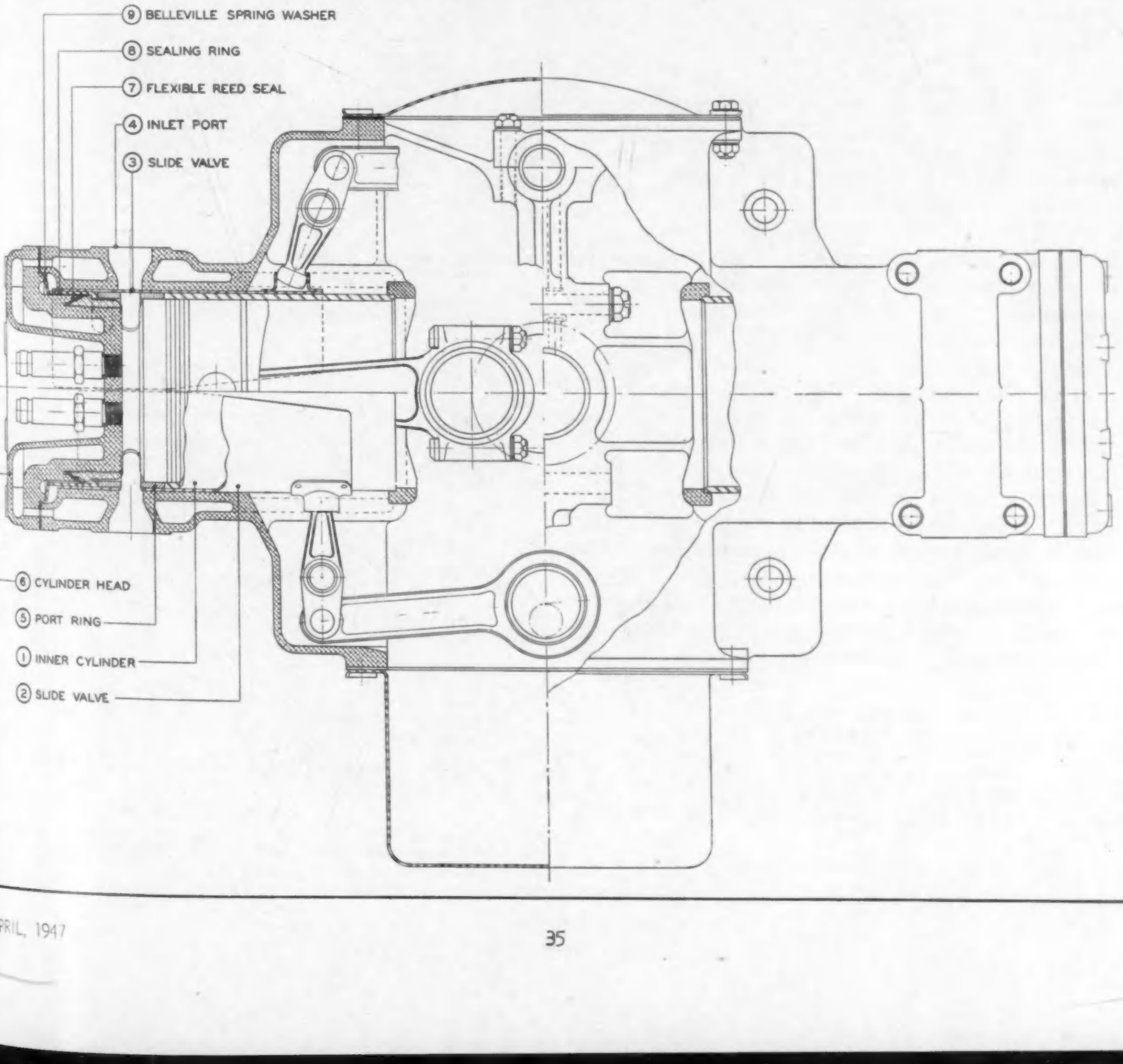
used. Compactness of the engine package permits a simple "V"-type construction.

Horsepower and torque of a 199-cu in. Skinner engine are compared in Fig. 1 with that of a 320-cu in. Packard engine (1931 model). The sleeve-valve engine developed 108 hp at 4000 rpm. It had an exceptional fuel economy of 0.49 lb per bhp.

These comparative tests disclosed another outstanding advantage of the Skinner engine – relatively low heat loss, as shown in Fig. 2. This makes for a considerable reduction in both cost and weight of the cooling system. A smaller capacity radiator and cooling fan can be used. Based on results of these tests, engineers felt that as much as a 5% overall gain in useful horsepower could be realized with the smaller cooling fan.

In more recent tests a slide-valve engine, installed in a Chrysler Royal Sedan, was compared with a 1941 convertible Pontiac, powered by an 8-cyl conventional engine, over a 2429-mile run

F THE SLIDE-VALVE ENGINE



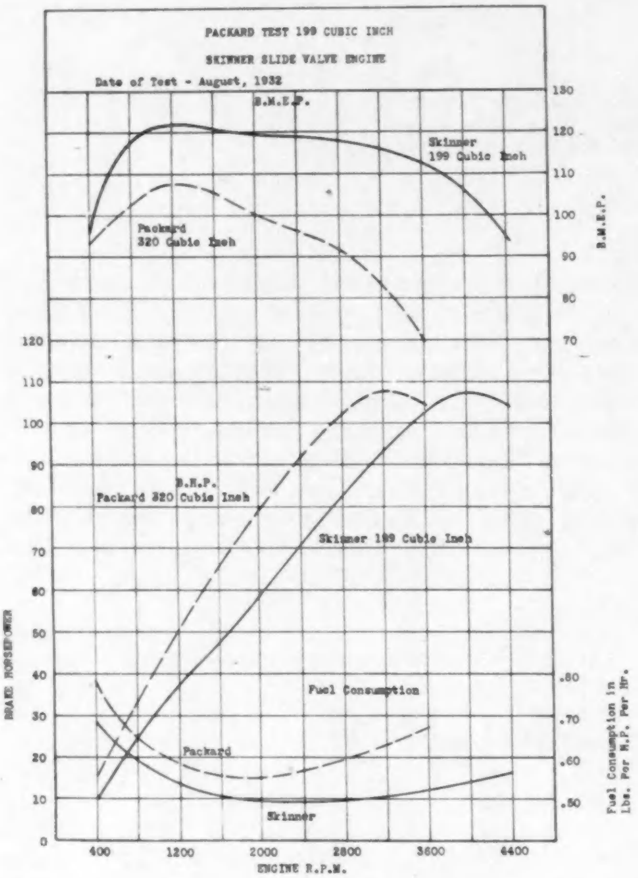


Fig. 1 – Performance comparison of a 199-cu in. sleeve-valve engine and a conventional 320-cu in. Packard engine

from Detroit to California. The Skinner engine, with a 9.5 compression ratio, averaged 18.6 mpg compared to 11.8 mpg for the Pontiac.

While the slide-valve engine now is a reliable powerplant that can compete commercially with poppet-valve types, its development was not without its headaches. Typical of the many bugs in this design that had to be eliminated was poor sealing of the port ring. Hot exhaust gasses had to be prevented from escaping, particularly since explosion pressures in the engine are quite high.

The problem centered about sealing of the space between the port ring and the cylinder head.

Early in the development it was thought that standard type piston rings in a circular collar pressed on the cylinder head would solve the problem. A hold-down ring was held against the large port ring by a thick copper gasket between the hold-down ring and the head. To hold the port ring securely to the inner cylinder, a number of small coil springs in a retainer gave a static spring pressure to hold the port ring at the top and bottom.

Four piston rings were installed on each head, sealed similar to rings on a piston. This design is shown in Fig. 3.

This sealing attempt nearly wrecked the engine during one test run. Shellac formation caused the four piston rings on each head to stick to the inside of the wide hold-down ring, preventing the static spring from functioning. Trouble was experienced in trying to start the engine again and also when power was used.

The trouble was caused by contraction of the inner liner which relieved static pressure on top and bottom of the wide ported sealing ring, permitting blowby at these points. As soon as the inner liner became heated, blowby would cease.

Fortunately, development of a new metallic gasket licked the problem.

As shown in Fig. 4, it consists of several very thin truncated, conical metal reeds that are nested together and machined so that they fit into a thin hold-down ring with an interference fit of about 0.002 in. per in. diameter. A shoe on the bottom of this thin sealing ring permits explosion pressure to seal or hold the port ring against the top surface of the inner cylinder.

A static spring pressure of about 400 lb on the sealing ring is constant on the port ring and inner

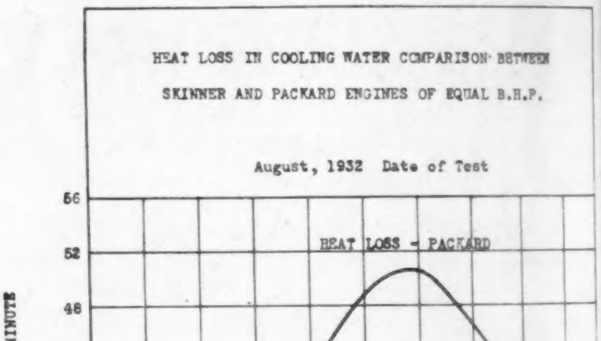


Fig. 2 – The Skinner engine had a much lower heat loss in cooling water than a Packard engine of equal brake horsepower. This inherently small heat loss permits use of smaller and less costly cooling systems

cylinder liner. Difference in area between the top of the inner liner and that of the sealing ring is about 3/4 sq in. At the instant of explosion, a very desirable booster pressure is added.

This pressure is evenly distributed around the entire circumference of the ported sealing ring. As soon as the explosion pressure is released, the ring is free to move. This gives excellent compression pressure for starting.

After years of testing and redesigning to take out these and other kinks, its creator looks forward to a rosy future for the slide-valve engine in powering motor vehicles.

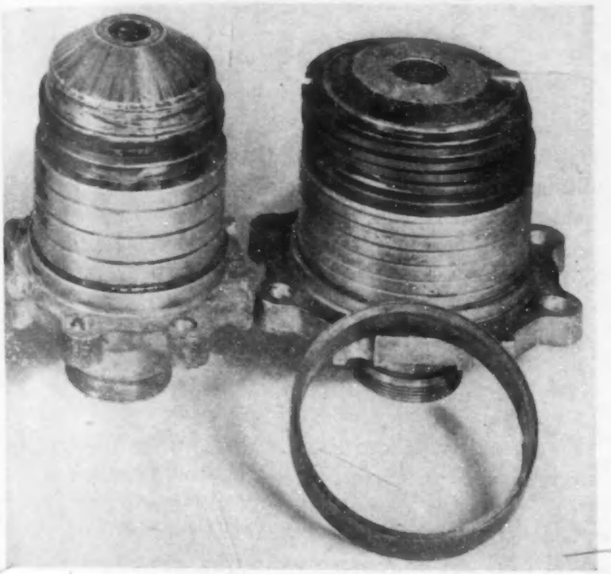


Fig. 3 - In this stage of developing a cylinder head seal, four piston rings were installed on each head. It was not successful

Fig. 4 - The final cylinder head seal that was adopted for the Skinner engine consists of several thin truncated metal reeds. A constant 400-lb spring pressure is maintained against the port ring and inner cylinder liner

FUEL KNOCKOMETER

continued from page 29

octane ratings. Similarly, the sensitivity of the bouncing pin may vary with engines and fuels.

Bouncing-Pin Guide Curve - In order to assure operating the engine at the proper compression ratio and knock intensity, the bouncing-pin guide curve was developed. When rating with the bouncing-pin, it is important to keep the deviation within ±0.025 in. on the micrometer. (The micrometer measures the cylinder-head height. This measurement is used in determining compression ratio.) However, when using the KM-3 electronic knockometer, deviation from the bouncing-pin guide curve does not appear to cause errors in octane ratings.

KM-3 and Bouncing-Pin Results Compared - A conversion factor may be used to tie the ratings of the bouncing pin and KM-3 together for different fuels, so that the KM-3 rating will indicate road performance to be expected and will give the equivalent bouncing-pin rating for manufacturing purposes. Incomplete data seem to indicate that the KM-3 increases octane ratings by 2.5 octane numbers, on the average. This difference is due to the fact that the bouncing pin does not always measure audible knock accurately. In fact, for some time it has been known that the bouncing pin will rate primary and secondary fuels as being of similar knock value, when actually, if rated by aural knock, the same fuels are several octane numbers apart. The KM-3, however, follows the ear.

In comparing the KM-3 and the bouncing pin, it appears that:

1. The KM-3 has improved accuracy because, by the proper choice of frequency and associated circuits, it has been made responsive to audible knock. Ratings obtained with the KM-3 more closely approximate fuel ratings on automotive engines.

2. Reproducibility has been improved because pickup position, cylinder guide curve, and even clamping sleeve tightness apparently do not affect octane ratings.

3. Dependability has been improved by eliminating the effect of building vibrations and the need for frequent and intricate readjustments due to mechanical wear and dirt.

4. It is more convenient to use because it will save time. It gives an accurate indication of engine knock, and should knock ratings change because of a change in engine conditions, the operator will know that he must investigate the engine, because there are no meter adjustments that can affect octane ratings.

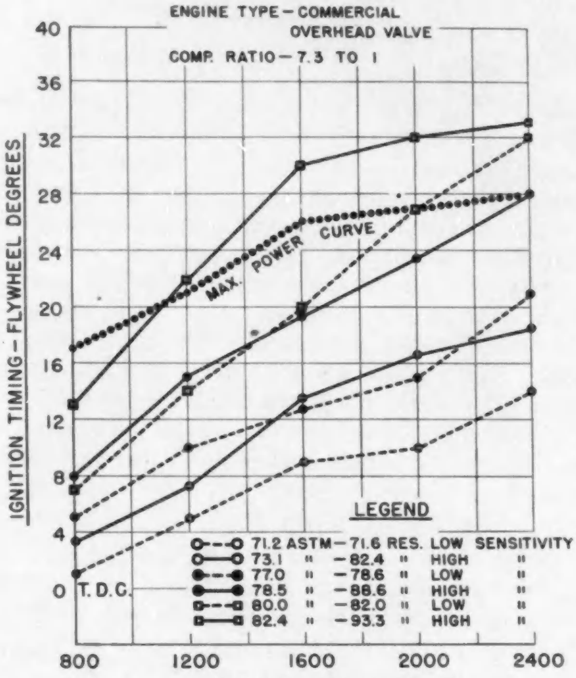


Fig. 1 – Data for these curves were obtained in tests of an engine now in production. They show the Borderline frameworks of several test fuels and the maximum power spark advance for a 7.3 compression ratio

MATCH ENGINES to
with Borderline Ra

FROM A PAPER* BY

Errol J. Gay

Manager, Commercial Engine and Fleet Division, Ethyl Corp.

and

Henry T. Mueller

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(This paper will be published in full in SAE Quarterly Transactions)

MATING engines with available motor fuels to achieve more horsepower per cu in. of displacement and designing engines for future low-cost adaptation to vastly improved fuels – perennial problems facing engine manufacturers – appear to be nearer solution using the Borderline Method of knock rating gasolines.

Achieving more power from a given engine depends on the selection of optimum compression ratio based on antiknock quality of current fuels. Until recently, engine performance had been determined in terms of the ASTM Motor Method octane number of fuels in current use. But mounting evidence showed that the same vehicle engine responds differently to gasolines of the same Motor Method rating.

Cognizance of the fact that two fuels of the same Motor Method number often perform quite differently in multicylinder engines led the Coordinating Fuel Research group of the Coordinating Research Council to adopt the new Borderline Method as a standard procedure for rating motor fuels on the road.

Fuels of the same Motor Method octane number may respond differently on engines because of the fuels' inherent sensitivity to variations in engine operating conditions – especially speed and spark advance.

Sensitive fuels are those with a higher laboratory octane rating by the milder Research Method test than by the Motor Method procedure. Degree of sensitivity generally is measured by the difference in octane numbers between the Research and Motor Method ratings. For example, a gasoline with a Motor Method rating of 78 and a Research rating of 84 has a 6 octane number sensitivity.

Current motor fuels are more sensitive than prewar gasolines and sensitive fuels are on the increase due to the advent of catalytic cracking. Although such fuels introduce new problems in fuel-engine relationships, manufacturers designing engines with a full knowledge of fuel sensitivity will achieve greater performance for any given Motor Method octane level.

Key to greater economy and performance appears to be the Borderline Method. Dynamometer test results using a modified Borderline Method to study possible effects of a fuel's antiknock quality on the selection of compression ratio and spark timing, have agreed reasonably well with actual road performance.

In conducting these Borderline studies, test gasolines are selected in pairs, each pair closely matched on a Motor Method octane number basis, but one of low sensitivity and the other having a high sensitivity rating. Such gasolines permit

*Paper "An Approach to the Selection of Compression Ratio as Related to Fuel Antiknock Quality," presented at SAE Annual Meeting on Jan. 7, 1947.

to FUELS

Rating Method

studying not only the effect of Motor octane number level, but also the effect of fuel sensitivity on the engine's knock-limited performance.

Good agreement between dynamometer tests and road results, experience indicates, requires a dynamometer setup and operating conditions approximating the engine installation in a vehicle.

Maximum power spark advance curves and Borderline curves are developed over the engine's operating speed range for each of the test fuels. A Borderline curve shows graphically a fuel's ability to tolerate spark advance throughout the engine speed range. It represents the dividing line between knocking and nonknocking operation.

Tests run on several engines of recent design corroborate the effectiveness of this method. From the data obtained in one case, a 7.3 to 1 compression ratio and a best compromise spark advance were selected for this particular engine using gasolines in the antiknock quality range of 72 Motor-77 Research to 81 Motor-86 Research octane number.

Fig 1 is a plot of curves showing the Borderline frameworks of the test fuels with the reference fuel blend curves deleted for simplicity. Comparison of the spark advance permitted by a high and low sensitivity fuel of essentially the same Motor octane number show that high sensitivity fuels in this engine permit greater spark advance than low sensitivity fuels.

Next problem is the translation of this information into permissible ignition timing for Borderline knock for several "average" type gasolines. A survey of regular grade gasoline throughout the country indicated that the average spread between Motor and Research ratings was five octane numbers.

Knock-limited distributor curves then were prepared for use with "average" fuels of 72, 75, and 78 octane number using a 7.3 compression ratio. Similar curves were developed for average fuels of 75, 78, and 81 octane number with an 8.0 to 1 compression ratio.

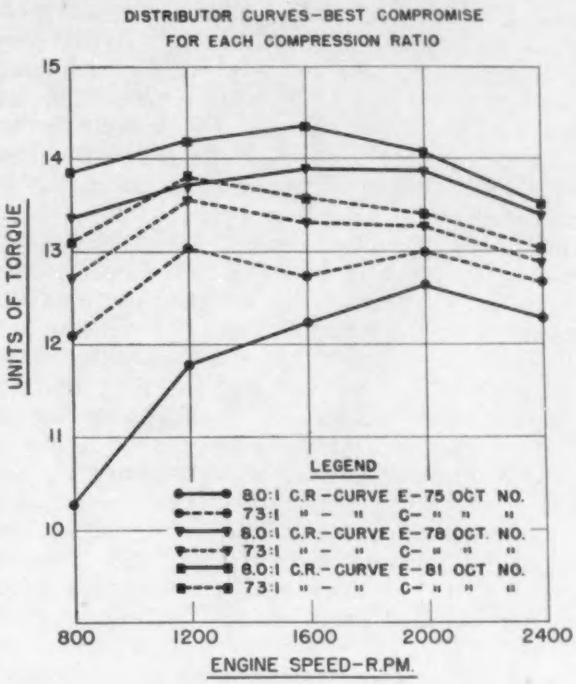


Fig. 2—Charting data obtained by the Borderline Method of knock rating gasolines using an engine of current design, showed that a 7.3 compression ratio (for this particular engine) gave higher torque than an 8.0 ratio using available fuels of 72 Motor and 74 to 79 Research octane number

Using distributor curves for the 7.3 and 8.0 compression ratios respectively, and adjusting their basic setting for knock-limited performance on average fuels of 75, 78, and 81 octane number, Fig 2 was prepared to show a comparison of the torque obtained. Reason for choosing the 7.3 compression ratio clearly is shown by this chart.

Since this particular engine was to operate on gasolines of 72 Motor and 74 to 78 Research octane number, the 7.3 compression ratio can be seen to give higher torque (for these fuels) than the 8.0 ratio. But Fig 2 also demonstrates that, using 78-81 octane gasolines, an 8.0 compression ratio, on this engine, offers the greater advantage.

On-the-road experience with this engine, currently in wide usage, justified the selection of a 7.3 compression ratio.

Merit of the Borderline procedure is that it enables the engine designer to attain maximum performance by selecting the proper-spark-advance and optimum-compression-ratio combination. But more than that, it permits the designer working closely with the petroleum industry to anticipate the availability of fuels of greater antiknock quality in current engine designs.

Understanding how the engine really judges fuel antiknock value will lead to development of fuel-engine relationships offering the ultimate in performance and economy.

INDIVIDUAL REAR-WH
OFFERS ULTIMATE IN

EXCERPTS FROM A PAPER* BY

Austin M. Wolf CONSULTING ENGINEER

INDIVIDUAL rear-wheel suspension opens up new riding comfort possibilities for vehicles not confined to city streets and boulevards. It will eliminate tramping of a rigid axle where road conditions now provoke it. Severe reactions on the frame and body are minimized over poor terrain. A high roll center is readily attainable in certain designs and inherent under-steer is easily accomplished.

One phase of riding comfort, which has always produced dividends from the earliest days, has been in the reduction of unsprung weight. This has been the case in the steady refinement of vehicles with rigid front and rear axles and lately in the incorporation of, and detailed improvements in, front individual wheel suspension. The greater the articulation, the better the riding quality, assuming that we are not always on "sandpapered" roads.

The search for greater ride comfort gave rise to many configurations for individual rear-wheel suspensions. Structural designs took the form of swinging axles, rigid-wheel support arms, elastic-wheel support arms, and combination-type support arms.

One of the earliest attempts with swinging axles was incorporated in the Rumpler car in which the inner ends of the axle tubes terminated in cylindrical segments, guided within a mating internally-machined housing acting as a guide and permitting vertical wheel oscillation about the axle center.

Structure Lightened

Next logical step was to eliminate the costly machine work and heavy construction of the Rumpler design and to substitute a yoke at the inner end of the axle tube, so typical in many of the Mercedes, Auto-Union, and Skoda models.

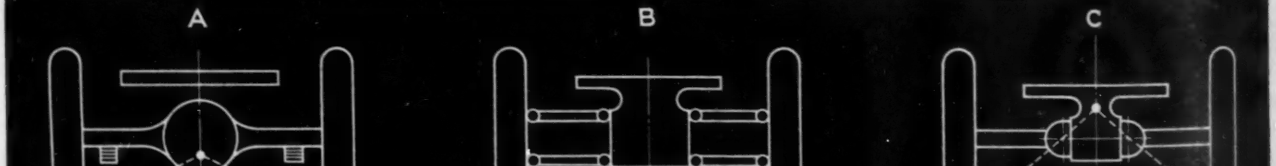
Third step in the development of the swinging axle, was in the substitution of a spherical head segment at the inner ends of the axle tubes. Since the spherical support would permit unrestricted movement of the wheel end of the axle tube, it became necessary to guide it by means of some form of radius rod, rigid or flexible. An early example of this construction is the Steyr.

This suspension consists of a transverse leaf spring back of the axle, transferring the load to the rear extremities of forwardly-anchored, longitudinal radius rods. In the previous examples of the swinging axle, the axle tubes remained continuously in a transverse, substantially vertical plane and in which wheel alignment (in so far as toe-in and toe-out are concerned) is maintained in spite of varying camber. In the case of the Steyr and other vehicles to be discussed with spherical inner ended axle tubes, the transverse plane alignment no longer prevails.

The Goodrich experimental chassis utilizes a diagonal Torsilastic spring-mounted arm to guide the end of the axle tube in lieu of a longitudinal radius rod. Hansa Lloyd provides a longitudinal radius rod at each side, attached to the wheel end of the axle tube and anchored at the forward end to a frame outrigger by a transverse pin surrounded by a liberal rubber bushing. Suspension is by a transverse leaf spring above the axle, with a universally-mounted, compression rubber-shackle between its extremities and the axle tube ends.

Fig. 1 – Location of roll center relative to the center of gravity is a vital element in riding comfort; height of center of gravity above roll center multiplied by the mass is the roll moment. This shows location of the roll center with a conventional rigid rear axle, A; parallel springs, B, and swinging axle, C

Fig. 2 – With the vehicle moving forward, this shows the effect of centrifugal force on the rear wheels and on the heavier loaded outer tire with a rigid rear axle, A; parallel springs or links, B, and swinging axle, C



WHEEL SUSPENSION
N RIDE COMFORT

In the Volkswagon a rectangular longitudinal spring-steel radius rod, with its major axis vertical, is bolted to the end of each axle tube, being pivoted in rubber bushings at its frame mounting. At this point it is secured to the splined end of a transverse torsion bar extending to the center of the frame. The Willys-Overland Model 6-70 utilizes a flexible radius rod in the form of a longitudinal semi-elliptic spring, providing Hotchkiss drive.

All of the swinging axles have a universal joint at each side of the differential, on the yoke axis or concentric with the spherical head, except for Rumpler, Tatra, and Steyr.

Concurrent with the different types of swinging axles, designers realized that radius rods might support the wheels directly instead of leaving them on the ends of the axle tubes. The first efforts consisted in the use of rigid longitudinal support arms of the trailing type (wheel behind pivotal anchorage). Some examples are the Campbell, Faudi, and Lancia "Aprilia."

Were we to transfer the Cord and Kaiser front drives to the rear of the chassis, we would have examples of a transverse leaf suspension with rigid center mounting in the former and torsion bar suspension in the case of the latter.

In the rigid support arms discussed, a two jointed propeller shaft must be used at each side, one universal being provided with a slip joint (usually the inner because of better protection from wheel splash) to compensate for the arcuate travel of the arm end.

The Harris Leon Laisne, utilizing rubber in compression, is a leading arm example; but it is readily conceivable that one might take the Cord or Kaiser chassis and turn them around.

A diagonal rigid support arm is feasible in conjunction with any type of suspension but I do not believe that any such unit has been built to date.

As was seen in the support arm group, discussion centered on longitudinal, transverse, and diagonally mounted arms, all of the rigid type. We can establish a group of elastic support arms. But the only practical forms have been used in the DKW and the present Gregoire front drives – two springs, one superimposed above the other. For the sake of discussion, we have transposed them to the rear.

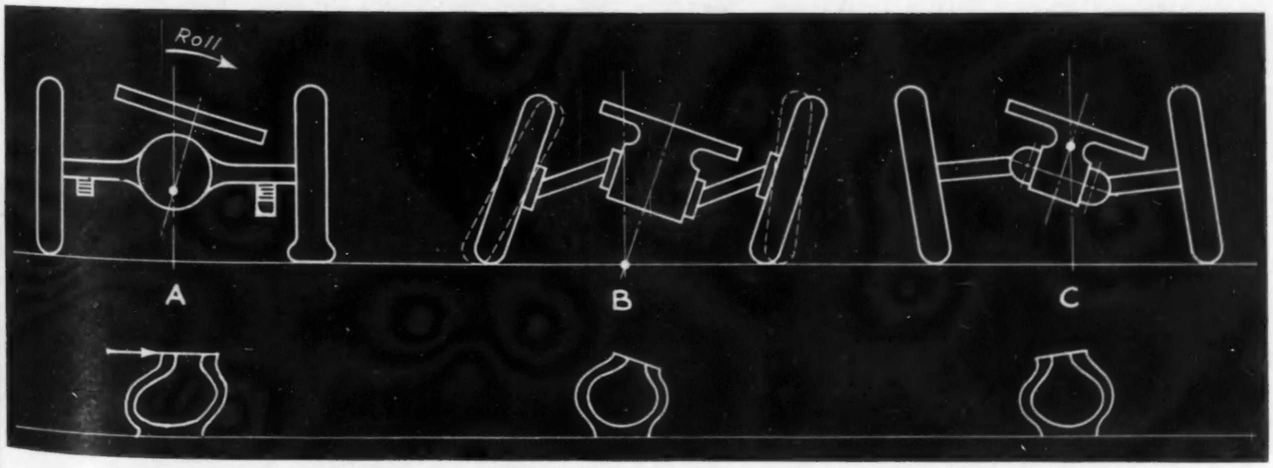
Providing Stability

A single elevated transverse leaf spring with two below it, spaced apart, would give a stable construction. The nesting of two upper and two lower transverse leaf springs is also feasible when attempting to resist drive and brake torque reactions to the utmost.

Another group might be set up – possible constructions utilizing various combinations of the other groups. A popular one is a transverse combination with side wishbones and a transverse spring or springs above or below. However, instead of a single cross spring, two were used; the rear springs were spaced farther apart than the front ones for greater torsional stability.

Another combination, used by the author twenty-six years ago, consisted of two parallel transverse

*Paper "Rear Individual Wheel Suspensions, American and Foreign," was presented at SAE Annual Meeting, Detroit, on Jan. 8, 1947.



springs, one above the other, which carried the load. Wheel driving and braking reactions were taken by diagonal tubular radius rods. The drive went through the left one to the driving gears. Experiments were made on the elimination of the differential.

Having covered the general structural arrangements, we might go into the geometric and dynamic effects on the different types of construction under varying conditions. The swinging axle, of course, gives a variation in camber and tread as the springs are deflected.

The wheels will describe a wavy trajectory. But in view of the distance traversed and the side flexibility of the tire structure, the results should be acceptable. Whatever impacts are set up, today's low pressure tire provides a resilient and shock-absorbing structure directly at their initiation.

Tread variation occurs with transverse parallel springs; but this in itself is no stigma. Thousands of Mercedes cars with such front construction as a dead axle and others using it as a driving axle, are running with no really deleterious effects on the tires.

Effect on Wheels

In the support-arm type of construction, the normally vertical planes through the wheels remain parallel. Under spring movement there is a slight variation in wheelbase due to the arcuate path of the wheel centers. The variation, however, is inconsequential.

The roll center of a vehicle is naturally a vital element of riding comfort in view of the extent of side movement of the passengers and their consequent discomfort. Thus the height of the center of gravity above the roll center is important since, when it is multiplied by the mass, we get the roll moment. The lower it is, the less need of sway-eliminators.

This article concerns itself only with rear wheel suspension. But in the final analysis of the entire vehicle, the front roll center must be taken into account since the longitudinal location of the center of gravity determines the lever arm length extending therefrom to the roll center axis immediately below it. The roll center axis is determined by a line connecting front and rear roll centers.

In Fig. 1A, the conventional rigid rear axle with Hotchkiss drive is diagrammatically shown in rear view. The roll center lies in a plane passing through the four spring eyes and best results are obtained with the main leaf fairly flat in the loaded position.

With parallel links, the roll center is located at the level of the road surface as indicated in Fig. 1B. Parallel springs would give a similar condition since the main leaf might be considered as a lever or link at each side whose length is approximately three-quarters the free length of the leaf (from the termination of the spring seat to the eye).

In Fig. 1C, it will be noted that the roll center of the swinging axle is above the axle center and is determined by the intersection of two lines drawn, one at each side, through the tire contact with the road and passing up through the universal joint center at that side. In the case of the Rumpler, Austro-Daimler, Tatra, and Steyr, the roll center is at the pinion shaft or the center of the axle.

Assuming the vehicle to be moving in a forward direction (away from us) and making a left turn, centrifugal force acting on the center of gravity will cause movement of the frame as indicated in Fig. 2A. The axle remains substantially parallel with the road and the wheels perpendicular thereto except for the slight increased compression at the bottom of the right or outer tire.

In a construction utilizing parallel links, parallel springs, or longitudinal wheel support arm constructions, when the mass sways to the right (based on making a left turn), the wheels remain parallel but are inclined outwardly at the top as shown in Fig. 2B. This is a quite different situation from the wheel posture of Fig. 2A, but is an inherent characteristic whereby the wheels remain parallel to the normal or static vertical vehicle center line. The dotted lines in Fig. 2B represent the outward extension of the wheels at the road contact where parallel links are used, with the lower ones being longer to maintain substantially constant track.

With the swinging axle, in Fig. 2C, a decidedly different result occurs whereby the wheels, under a similar situation to Fig. 2A and 2B, lean inwardly instead of outwardly as in Fig. 2B or substantially vertical as in Fig. 2A.

It will be interesting to receive comments from the tire engineers regarding the three variations in tire posture, due to centrifugal loading and wheel position: (1) whether normal to the road, or (2) tilted outwardly, or (3) inwardly.

An exaggerated condition for each phase is depicted in Fig. 2 representing the heavier loaded outer tire. We know that a driven tire has slightly less cornering power than a purely rolling one. What effect the inclination would make on characteristics such as cornering power, and adhesion would provide an interesting study, combined with modifications in the slip angle due to geometrical variations which occur in swinging axles with radius rods.

Use of radius rods with a swinging axle is diagrammatically shown in Fig. 3A. Since the two universal joint construction is mostly used, it forms the basis of the figure and it will be noted that wheel translation is about axis A-A when it rises or falls. Assuming the right axle tube to be horizontal under a given static load, the wheel will be vertical. Upon upward movement of the wheel,

it not only leans out at the bottom but toes-in at the front, as indicated by the dotted outline.

Were the swinging axle to go over a transverse obstruction of the same height under each wheel, we would obtain the "bow-legged" condition shown in Fig. 3B. The variation is small and the slip angle induced would have but slight effect on the cornering power in the attempt of each wheel to steer the rear end of the vehicle in opposite directions. Even though small, cognizance should nevertheless be given to this condition since cumulative effects might be noticeable were the front end to "act up" in the wrong direction.

In taking a left turn, diagrammatically shown in Fig. 3C, the raising of the right wheel relative to the frame (or considering the rollover of the body with the resultant depression of the frame at the right toward the axle due to compression of the suspension mechanism) results in the toe-in of this wheel as previously noted in connection with Fig. 3A.

With the corresponding increase in distance at the left side between the frame and the axle tube or extension of the suspension system, we would have the equivalent of dropping the left wheel. Its rotational position is then determined by the diagonal axis running from the left radius rod frame anchorage through the center of the left universal joint. Such rotation causes leaning out at the bottom (toward outside of curve) and toeing-out of the left wheel establishing, with the toed-in right, an under-steer condition for the rear axle.

The extent of variation in slip angle will, of course, be dependent upon the total vertical wheel movement and in proportion thereto. The constant level mechanism in the Goodrich chassis is a very valuable contribution toward minimizing the extent. Of course, there are many tricks in the tilt of the anchorage axes to improve the geometrical relationships; the Goodrich chassis incorporates one to advantage.

In the case of the Adler chassis in which the radius rods extended rear of the axle, the opposite effect would take place as shown in Fig. 3D with the right wheel toeing-out and the left wheel toeing-in. In so making the left turn, the rear wheels cut down the already established turning radius, whereby over-steer results.

Should the front suspension provide an over-steer condition in conjunction with the condition shown in Fig. 3D, there would then be cumulative over-steer. In under-steer with the front wheels, coupled with the under-steer portrayed in Fig. 3C we have a safer condition.

For slow moving vehicles, over-steer might be a desirable characteristic; but since practically all cars are used in relatively high-speed work, under-steer as an inbuilt characteristic is desirable. An over-steer condition with both front and rear wheels contributing to this effect would result in a dangerous, ever decreasing turning radius.

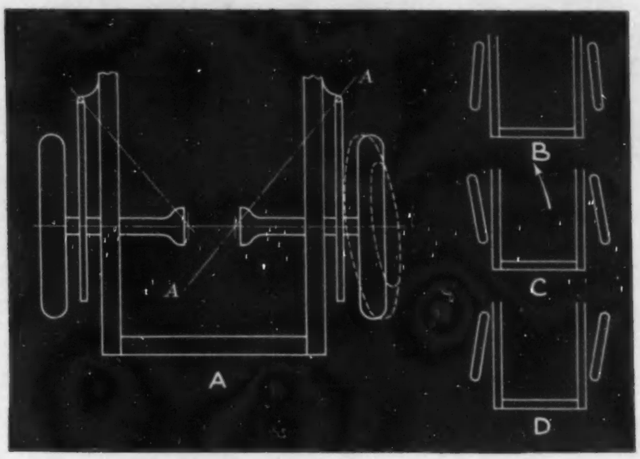


Fig. 3 – Shown here are the reactions of the rear wheels of a swinging axle with radius rods for various conditions. A shows that wheel translation is about axis A-A when the wheel rises and falls; B depicts the "bow-legged" condition when going over an obstruction of the same height under each wheel; under-steering condition in the rear axle in a left turn is shown in C; with the radius rod at the rear of the axle, the over-steer condition in D would result

It will now be realized why the radius rod of the Adler chassis is pinned to the rear of the frame by a diagonal pin whose axis passes forward through the universal joint center on the corresponding side. The inherent over-steer condition of the Adler rear axle must have been appreciated by others since it has not been copied.

While Fig. 3B, 3C, and 3D do not show the inward or outward tilt of the wheels, it exists nevertheless in conjunction with the variation in toe-in and toe-out, the latter phase only being depicted in the diagrammatical sketches. Thus we have to cope with variations in camber, tread, and "toe" in swinging axles with radius rods.

Referring again to Fig. 3C and 3D, the wheels are not fully parallel in turning due to the roll center which raises the left universal more than it depresses the right. The latter causes the right wheel to assume a slightly lesser angle which conforms to true steering geometry – the outer wheel should have a lesser angle, being at a greater radius from the turning center which is shifted back of the extension of the rear axle center line in Fig. 3C, and ahead of it in Fig. 3D.

Since the transmission, drive gears, and their housing are mounted on the frame, all designs – other than the earliest – insulate these members from the frame by rubber mountings, most often in the form of rubber biscuits. The mounting cannot be too soft since the alignment of the wheels in the case of swinging axles is dependent upon the housing and in turn the mountings to properly position them.

This in itself is a study in rubber mountings; but the problem is not a difficult one. It is also desirable to insulate the propeller shaft, which would otherwise be recipient of engine and transmission noises, by the use of rubber disc, bushed

concluded on page 47

Reduce Noise Nuisance in

BASED ON PAPERS* BY

Leslie J. Trigg Chief Engineer, Sensenich Bros.

and

B. J. Simons Chief Division Engineer, Stinson Division, Consolidated Vultee Aircraft Corp.

NOISES annoying people both outside and inside personal airplanes must be silenced first at the main source – the propeller – before tackling secondary items if flight discomfort and civic objections to airports are to be overcome, Trigg and Simons agree.

Most noises can be traced to (1) the propeller-engine combination and (2) airflow over the outside surfaces. In addition to the propeller and engine-exhaust noises, the powerplant unit induces resonant vibrations in the aircraft structure. From outer airflow also stem vibrations and high-frequency cabin whistles.

Quieting the propeller is largely the propeller designer's chore, while the other ear-disturbers must be muffled by the airframe engineer.

Key to quieter propellers is vastly decreased tip speeds, declares Trigg. He shows that:

Drastic tip-speed reduction would require major redesign of present-day light aircraft to prevent reduced airplane performance. While an intermediate step, and a necessary one, in reducing propeller-generated noises is refinement of blade design features, real inroads can be made by modifying the entire propeller installation.

Airfoil type, the first blade characteristic worth probing into, should be designed to cut down compressibility losses. This in turn will reduce sound level intensity at given tip speeds under design aerodynamic loadings.

Airfoil Design Foibles

But putting this theory into practice is not easy; propeller blades usually must operate through a wide angle-of-attack range, from high disc loadings at take-off and climb to light loadings at cruise and top speed. Airfoil sections desirable from a compressibility standpoint generally are limited in angle-of-attack range.

Second important fact the designer can use to advantage is that blades with low airfoil thickness-chord ratios (thin blades) give higher critical speeds at low angle of attack. Therefore, their sound intensity should be lower. The problem here is keeping the blades as thin as possible within limitations of materials and tooling. While effect of blade surface texture on critical propeller section speed is not fully known, metal tipping – now widely used – probably does increase the noise level. It produces a ridge on the blade surface that lowers propeller thrust.

Redesigning blade elements to operate at lower angles of attack and higher section speeds is a fourth way of modifying the blade for relative freedom from noise.

Gains achieved by the above refinements, while only a partial solution to the noise problem, are attractive to engine and airframe manufacturers since they entail no redesign of their products. But full significance of these parameters is at best foggy. It remains for the NACA and CAA, in cooperation with industry, to evaluate these factors through academic research.

Four Ways to Quiet

Real answer to the demand for a quieter propeller is the reduction of tip speeds – and it cannot be compromised. Retarded tip speed can only be brought about by:

1. Slower turning engines or engine-propeller reduction gearing;
2. Multi-bladed propellers;
3. Wider blades;
4. Combination of any of these.

The first method – reducing propeller rpm – must be accomplished without losing propulsive efficiency. Larger diameter propellers will turn the trick since a propeller absorbs power more rapidly with increase in diameter than it would lose power with a corresponding reduction in rpm.

Doubling the number of blades will reduce tip speed by allowing a 14% reduction in propeller diameter. More than four blades requires a variable pitch propeller for cruising speeds over 130 mph to retain favorable performance. Increased cost of a multi-bladed propeller is seen by airplane manufacturers as a major objection.

Doubling blade width makes possible a 12%

Personal Planes

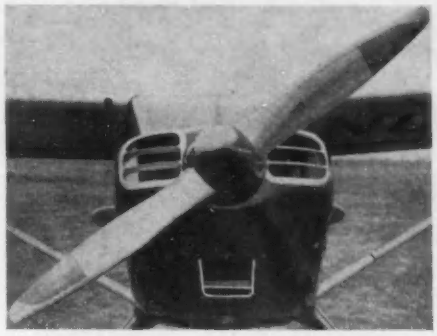


Fig. 1 – Noise produced by the conventional propeller, above, was reduced by using wider blades and slowing propeller rotation in the installation at the right

reduction in propeller diameter. But as with multiple blades, wider blade propellers of the fixed-pitch type will give greater variation in propeller rpm with different airspeeds.

Considerable promise is held for the noise-reducing combination of wide-bladed twin-blade propeller and a slow propeller rotation. Effectiveness of teaming these two quiet-producing modifications was demonstrated by the installation shown in Fig. 1.

Less noisy cabins also have been achieved by wing and pusher installations.

But whatever the developments emanating from the propeller manufacturers will be, the speed with which they will be made available commercially depends upon the immediate market for these products. Additionally, steps taken by the propeller manufacturer will depend on propeller shaft speeds and engine power ratings selected by the airframe manufacturer.

Assuming he has anticipated these elements and learned the clear-cut relationship between blade shape and propeller noise, the designer could then determine tip speed limits acceptable from a noise standpoint. With these facts he could draw charts, such as Fig. 2. It will serve as a guide to selection of the best propeller speed and diameter corresponding to a given engine horsepower and top airplane speed, if a particular tip speed (in this case 800 psi) is not to be exceeded.

Job for Plane Designer

Even after the propeller people have brought the racket of the major noise-maker within tolerable limits, there are enough noise sources left within the airplane to warrant the airframe manufacturer assuming the role of a designer-for-silence.

Reducing engine exhaust noises, vibrations, and whistling cabin leaks are his responsibility, declares Simons.

Showing how the problem was approached for one airplane, the Stinson Voyager 150, he points out that:

Serious handicaps confronting the designer in muffling the exhaust of this airplane were weight and exhaust back pressure. The final muffler design did not severely penalize the airplane in either respect. Total weight of the muffler installation is 3.6 lb and the maximum back pressure obtained is $18\frac{1}{2}$ in. of water for a climb condition at 80 mph. (The engine manufacturer's limit is 26 in.)

Two mufflers were used – one for each 3-cyl bank. A tail pipe also is provided from each muffler to the outside of the plane. The muffler itself is an expansion chamber into which exhaust from each of the three cylinders passes. Expansion within this chamber forces the gases through a perforated tube, concentric with the outside of the expansion chamber.

Cabin Sings a Tune

Noise level within the cabin itself stems from the resonant frequencies set up by the engine-propeller combination. Clues to reducing these interior noises can be uncovered by operating a

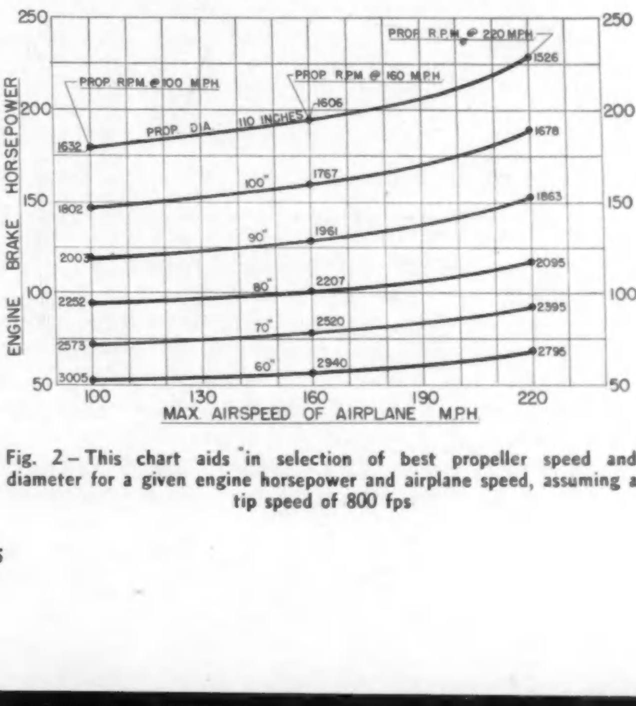


Fig. 2 – This chart aids in selection of best propeller speed and diameter for a given engine horsepower and airplane speed, assuming a tip speed of 800 fps

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*Trigg paper, "The Propeller Aspect of Practical Problems in Reducing Noise in Personal Planes" and Simons paper, "Practical Problems in Reducing Noise in Personal Planes – Engine and Airframe Aspect," were presented at SAE Annual Meeting, Detroit, Jan. 9, 1947.

Ounce-of-Prevention Noise Approach Okayed

From discussions by

DAVID BIERMAN, P. E. R. BRICE, S. M. GAMSU, PAUL H. GEIGER, W. C. JAMOUNEAU, AND ARTHUR A. REGIER

Attacking light-plane noise at its source met with agreement among discussers of this paper who also added several tips for antinoise campaigners.

Sound-absorbing insulation in itself is not a cure-all, warns P. E. R. Brice, of Republic Aviation Corp. Unless cabin trim cloth is porous enough to permit sound to travel through the insulating blanket, insulation will be useless. Nonporous materials such as leatherette, while attractive, defeat the insulation's function.

Arthur A. Regier, of NACA, points to limitations in the effectiveness of sound-absorbing materials. While they cut out some high-frequency noises, they do little with low-frequency sounds – where most noises are found. Getting to the core of the noise, the propeller-engine combination, will accomplish a dual function, he believes. Both airport and cabin noises will be reduced without incurring weight and cost penalties of damping devices.

Formula for quieter propellers, points out David Bierman, Hartzell Propeller Co., is reduced disc loading and tip speed as well as refined blade shape. Critical compressibility value is about 900 fps. Above it, noise level increases rapidly.

J. M. Gamsu, McCauley Corp., goes along with the contention that shorter and wider blades are quieter. He finds a by-product value in smaller diameter propellers. They not only increase cruising speed 5 to 8%, but also improve take-off and climb.

While electronic devices are valuable noise-detection aids, says Paul H. Geiger, University of Michigan, the ear is a remarkable instrument and should augment detection machinery. After all, the entire problem is one of catering to the ear. He shows that good vibration-damping is lost if just one or two weak spots remain in the structure. In such cases, the ear can be quite informative under proper experimental conditions – as effective as sound level meters and analyzers.

Noise-transmission properties of light windows and windshields also are worth looking into, observes W. C. Jamouneau, Piper Aircraft Corp. As plane speed increases, aerodynamic forces cause these parts to drum. A preformed bulge or crown in the panel, increasing its stability, is one possible remedy.

vibrator on the engine through frequency ranges equivalent to normal engine rpm.

It's surprising to note the number of cabin parts that become resonant at various operational frequencies.

Most noises – especially those coming within normal cruising range – can be detected by this method. Experience has shown it advisable to insulate all floor boards and other structural panels with resilient tape as well as to sound-deaden certain metal panels, such as the instrument shroud.

Another experiment also proved valuable in clearing up extraneous noises. The airplane was flown to a high enough altitude; the engine was cut out, stopping the propeller; and the airplane permitted to glide at any normal operating speeds.

This made it possible to detect vibrations of various cabin parts and cabin leaks without powerplant interference. It's particularly useful in locating serious noise leaks around doors and windows. Being high in pitch, these noises are quite annoying and fatigue-inducing for the pilot.

Table 1 – Overall Sound Level Measurements of the Stinson Voyager 150

Condition	Rpm	Overall Sound Level, in decibels
Engine warm-up	1200	114
Take-off	2375	120
Climb	2400	115
Cruise	2500	115
Full power – level flight	2700	115
Power off – glide, flaps down	900	98

After eliminating structural vibrations in the Voyager, the airplane was soundproofed by enclosing as much of the cabin area as possible in a Fiberglas blanket. Most important area, the firewall, is insulated by cementing in place a loosely-quilted ½-in. Fiberglas blanket weighing 1.22 lb.

Next important area, the metal shroud aft of the firewall that extends around the fuselage forward of the doors, must be completely deadened as the panels are easily excited by propeller and exhaust pulsations. A ½-in. covering weighing 0.92 lb blankets this area.

Table – 2 Comparison of Noise Levels In DC-3 and Stinson Voyager

	Noise Level 75-150 Frequency Range	Noise Level 1200-2400 Frequency Range
Voyager	115	83
DC-3		
Pilot's position	104	75
Forward – center cabin	106	66
Aft – center cabin	92	62

A sheet of Fiberglas covering the cabin roof and upper side surfaces is held in position by the outer fabric. It weighs 1.26 lb. Cabin side walls below the rear windows and rear wall are similarly treated.

This entire soundproofing installation requires 95.5 sq ft of ½-in. Fiberglas sheet weighing 4.27 lb. Total cost is $18.48 – $12.68 for material and $5.80 for installation labor.

An evaluation of the effectiveness of each piece of soundproofing would be interesting. Although such evaluations have not been made, sound surveys have been conducted for overall sound level and frequency analysis.

Using measuring equipment for frequency analysis in the air is not feasible. But overall noise level measurements were made on the ground with a fixed-pitch propeller during engine warm-up,

take-off, climb, level flight at various speeds, and in power-off glides.

Readings taken with the sound-level meter, held first near the pilot's right ear and then at the ear level of the rear-seat passengers, were within 2 decibels of each other. Results of these measurements, shown in Table 1, give the average of the two meter values.

While some benefits were achieved, comparisons with measurements of the prewar DC-3 at the two most generally used frequencies, as shown in Table 2, demonstrate the need for further reduction of noise level in the Voyager.

These tests, run on one of the early models in the series, stressed the importance of avoiding all cracks and openings in the insulating structure. The smallest cracks nullify the best soundproofing installation.

Noise reduction within the airplane extends beyond the designer's drawing board. Manufacturing and inspection departments must give constant attention to the problem to maintain a careful control of all factors involved. Providing tight-fitting joints is just one example.

ABC's of Propeller Noise

From a discussion by

W. C. JAMOUNEAU, Piper Aircraft Corp.

Shorn of technical phraseology, propeller noise results only from the fact that air (or anything, for that matter) doesn't like to be shoved around too violently. And if it is, will roar its disapproval.

To propel a plane through the air, we must accelerate a large mass of air from a state of rest up to a velocity of about 100 fps, and this must be accomplished in a very small period of time. It appears that the ultimate solution of the propeller noise problem lies in the following:

1. Finding a method of bringing the air up to speed gradually;

2. Operating on a larger mass of air so that the velocity differential is less;

3. Working more effectively on the air now passing through the propeller disc by imparting energy to more air particles through plurality of blades. A combination of several of these factors may be necessary to produce the desired result.

REAR-WHEEL SUSPENSION

cont. from p. 43

universal joints, or the rubber sleeve type used in the Goodrich chassis.

All driving torque reaction is taken up by the frame from the differential housing in view of the wheel mounting directly on the end of the axle shafts. This is not the case in the military version of the Volkswagon (the German Jeep) since there is a small spur gear reduction to give greater ground clearance and added climbing ability. Driving reaction is, therefore, taken up by the flexible radius rod. It is bolted to the gear housing and flexes as the axle tube rises or falls due to the arcuate path of this anchorage in a transverse plane.

Brake reaction (assuming wheel brakes) is transmitted to the frame through the fork-ended axle tubes of swinging axles and through radius rods when used there. The wheel support arms do likewise. In the case of the transverse parallel springs or the combination of springs and links, they transmit the torsional driving and braking reactions to their anchorages on the frame.

As the suspension becomes increasingly loaded in any type of individually sprung rear axle, the ground clearance decreases whereas in the conventional rigid rear axle, it remains constant (other than tire deflection). We know that when a live, rigid axle differential housing becomes "hung up," traction is lost. However, with individual wheel suspension, the case is not always this bad since by reducing the load, the tires can regain their grip to a certain extent, depending entirely upon the immediate flotation conditions.

In view of the use of a single universal joint at each side in swinging axles, it would be desirable that they be of the constant velocity type to avoid shaft accelerations and decelerations at maximum angles which would occur with the cross pin type. However, all European cars incorporate it.

In the use of two joints at each side, in all other axle groups, the cross type is satisfactory in that one joint will cancel out the variations of the other with proper pin alignment. The Cord construction incorporated two Bendix-Weiss joints at each side. Instead of a spline slip at the inner, it was made with extended ball grooves ground right in the joint structure. The joints of the longitudinal propeller shaft have merely to take care of any frame deflection or misalignment of parts.

Since we are continually aiming toward better riding performance, rear individual suspension will be with us if the advantages are not outweighed by the disadvantages of (1) greater cost of fabrication, (2) possible shorter life of such parts as universal joints and the wheel mounting anchorages as compared with the rigid axle system, and (3) the elimination of one large component on the assembly line and substituting a number of smaller ones.

FUEL INJECTION for Low-

EXCERPTS FROM A PAPER* BY **George M. Lange**
Fuel Injection Division, Ex-Cell-O Corp.

This paper describes a compact injection system now available for small, spark-ignited aircraft engines.

History

Since the internal-combustion engine was first conceived by Abbé d'Hautefeuille in 1678, better fuel-air mixtures and more efficient methods of getting the charge into the cylinder have been constantly sought. Carburetors have been the almost universal means of supplying the proper mixture of fuel and air, although the advantages of injection have been fully realized for many years.

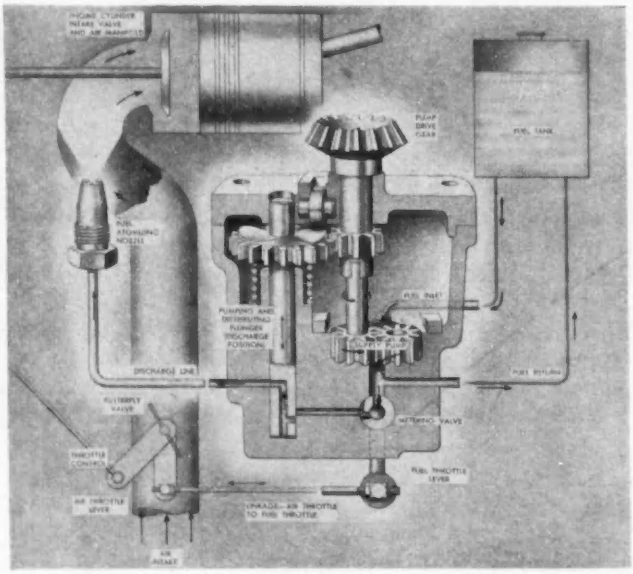

Fig. 1 – Flow diagram for intake metering injection system (single pumping and distributing plunger)

The units making up a fuel injection system are: fuel metering and injection pump, air metering throttle and linkage, discharge lines, and atomizing nozzles.

An injection pump is a device to meter individual charges of fuel mechanically and to deliver these metered charges at properly timed intervals through atomizing nozzles to the engine cylinders.

Present Design

The basic system is shown in Fig. 1. It incorporates intake metering of fuel with a mechanical linkage between the fuel and air throttle lever arms. Fuel flows from the fuel tank through the supply pump to the metering valve. The amount of fuel metered to the pumping plunger is dependent on supply pump pressure and throttle position. The pump throttle is calibrated and linked to the air throttle in the correct relationship to provide the proper amount of metered fuel

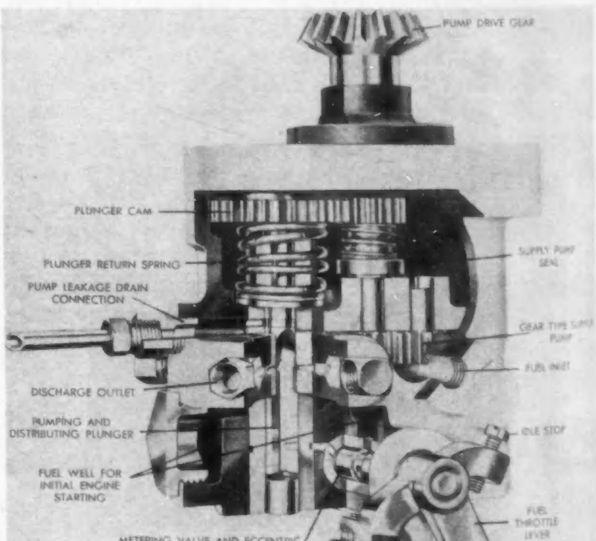

Fig. 2 – View of 4-cyl injection pump

*Paper "Fuel Injection for Light Aircraft," was presented at the SAE Annual Meeting, Detroit, Jan. 6, 1947.

Horsepower Aircraft Engines

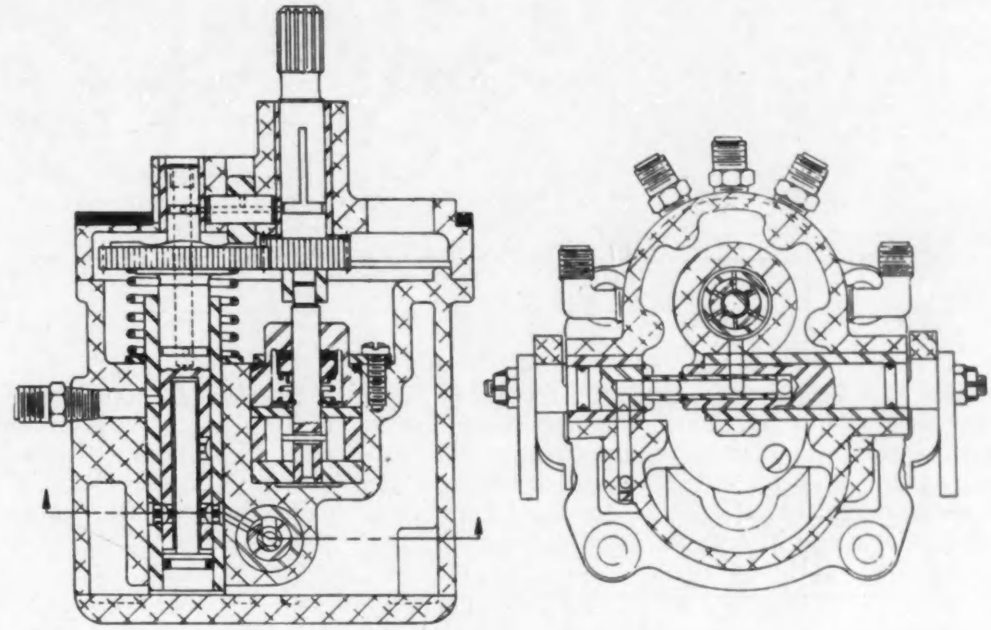

Fig. 3 – Views of L-6 design incorporating an idle fuel cut-off and manual mixture control

for the corresponding metered airflow over the operating range of the engine.

The supply pump delivers about three times as much fuel as is required by the engine and the excess fuel is returned to the tank. An orifice is installed in the return line so that at full engine speed the transfer pump delivers 30 psi pressure in the fuel reservoir.

The injection pump (Fig. 2) consists of three principal parts, namely: fuel supply pump, fuel metering valve, and pumping and distributing plunger. It is suitable for both manifold and cylinder injection.

The fuel is metered on the intake side of the pumping plunger. This basic design is called the intake metering fuel injection system.

Design Advantages

This design was selected for production because:

1. Past experience had indicated the desirability of having a supply pump to circulate the fuel to prevent vapor lock and to secure desired metering characteristics.

2. Intake metering and a mechanical linkage between injection pump and air throttle were chosen, as they provided a simple means of maintaining good fuel-air mixtures over the range of speed-load conditions encountered with variable-pitch propeller installations.

3. A single pumping and distributing plunger was chosen in place of multiple plunger designs to obtain equal distribution of fuel to all cylinders readily and to simplify design.

Mechanical Operation

The pump drive operates at engine speed; the supply pump is driven from the end of this shaft. (See Fig. 3.) A two-to-one reduction drives the pumping and distributing plunger at camshaft speed. The pump is a 6-cyl design, so that there are six lobes on the cam face. The cam face rests against a roller in the pump base and is held in place by a coil spring. The pumping and distributing plunger makes six strokes per revolution. On the up stroke of the pumping plunger the fuel metered during a certain interval is drawn into the plunger reservoir during the time the intake ports in the pumping plunger are in registry with intake ports in the plunger sleeve, which in turn are connected to a duct leading from the metering valve.

As the plunger reaches the upper end of its

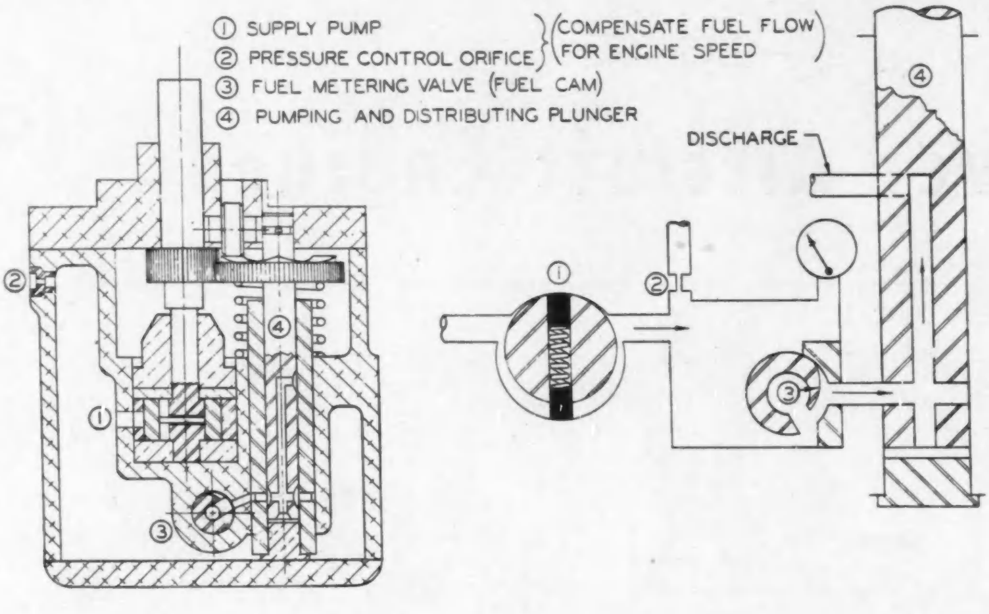

Fig. 4 – Fuel metering and distribution of injection pump

stroke, the intake ports go out of registry with plunger rotation and, as the plunger starts on the down stroke, the discharge outlet comes into registry with an outlet in the plunger sleeve and the metered quantity of fuel is discharged through this outlet port into a fuel line, which conveys the

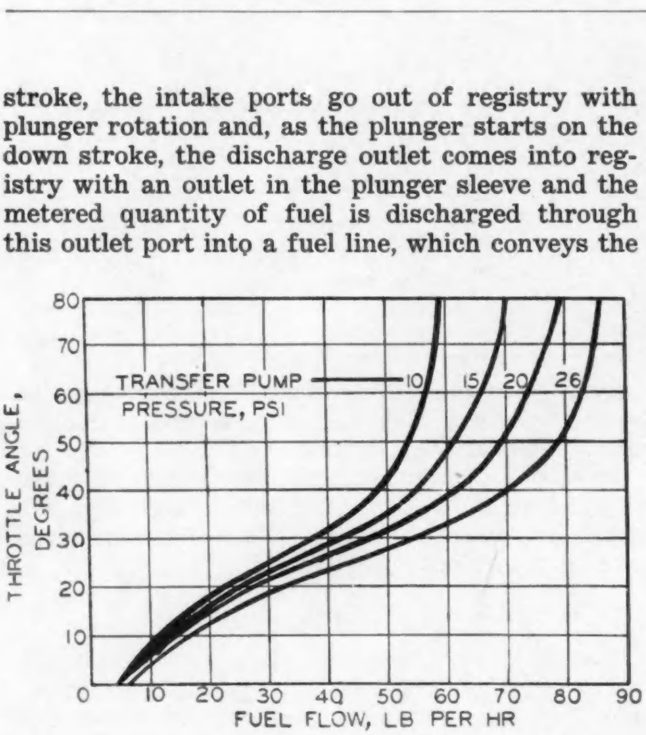

Fig. 5 – Effect of supply pump pressure on injection pump delivery

metered fuel to an atomizing nozzle located either in the manifold, cylinder head, or cylinder-head intake port.

The supply pump delivers the fuel to a reservoir. Between this reservoir and the passage leading to the pumping and distributing plunger is located the fuel metering valve or fuel cam. (See Fig. 4.) The fuel line contains an orifice to return the excess fuel pumped by supply pump. The orifice size is normally set to give a reservoir fuel pressure of 30 psi at full engine rpm.

The fuel throttle is actually an orifice varied in size by angular movement through an arc of 75 deg. The amount of metered fuel is dependent on orifice size and reservoir pressure. The fuel cam or metering valve groove is calibrated to meter the proper amount of fuel for an engine over its operating range with a fixed return fuel line orifice size. Further regulation and control of metered fuel quantities can be obtained by varying fuel reservoir pressure. Mixture control is obtained by varying this reservoir pressure.

Test Stand Performance

Tests of a model L-6, 6-cyl injection pump calibrated for a Franklin 6AL-335 engine show

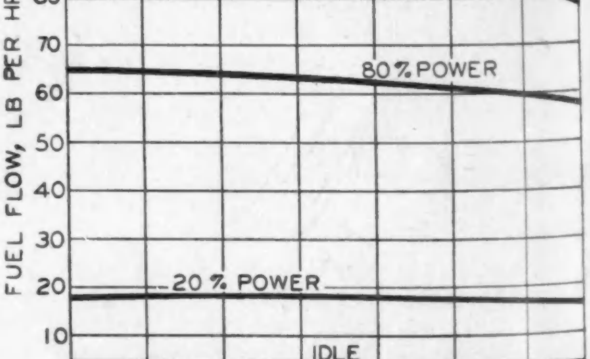

Fig. 6 – Effect of fuel inlet temperature on injected fuel delivery

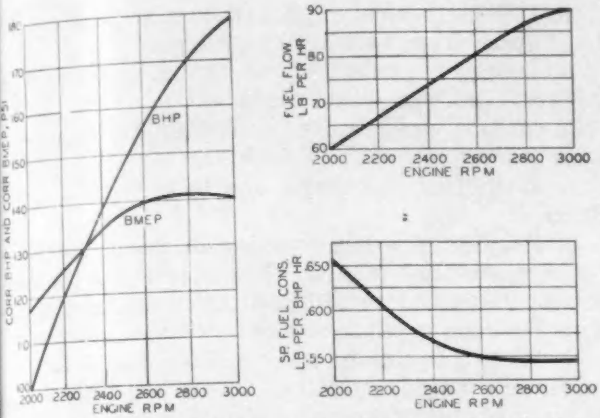

Fig. 7 - Fuel throttle performance of injector-equipped Franklin 6AL-335 engine

that full displacement delivery is greater than actual engine requirements and that distribution varies from 2½% at full throttle to 7½% at 20% power. They also show that inlet pressure does not affect supply pump pressure or delivery over a range equivalent to a head varying from 50 in. to −40 in.

The fuel supply reservoir pressure can be varied by varying the fuel return outlet orifice size. This pump characteristic is utilized in matching injection pump delivery to engine air requirements for normal full-throttle variable-speed conditions and part-throttle fixed-speed variable-load conditions. Such operating conditions are encountered at take-off or in flight with a variable-pitch propeller.

The effect of supply pump or fuel reservoir pressure on injection pump delivery for constant-speed and throttle conditions is illustrated in Fig. 5. This pump characteristic is used to obtain mixture control and altitude compensation. Full-throttle delivery can be varied from 90 lb per hr to 58 lb per hr by reducing supply pump pressure from 26 to 10 psi.

At engine speeds comparable to cranking speeds the lift ability of the supply pump is insufficient for most low-wing plane installations. At engine speeds corresponding to idling, the lift ability of the supply pump is adequate for all usual low-wing installations.

The effect of fuel temperatures on injection pump delivery over a temperature range of 60-130F is shown in Fig. 6. There is approximately a 10% drop in injected fuel delivery over this temperature range at full and 80% throttle, a 5% reduction at 20% throttle and engine idle.

Engine and Injection Pump Calibration

The calibration of injection equipment for a particular engine is accomplished in a normal manner. "Fishhooks" are run for various air-throttle angle positions corresponding to predetermined power outputs. The fuel requirements of the engine over its operating range are determined, and a fuel requirements curve is established for the engine with limits of ± 3%.

Dynamometer Performance

Fig. 7 shows full-throttle performance for the 6AL-335 engine, which is normally rated at 165 hp at 2800 rpm. Fuel flow is slightly richer than required for best power.

We are often questioned about engine per-

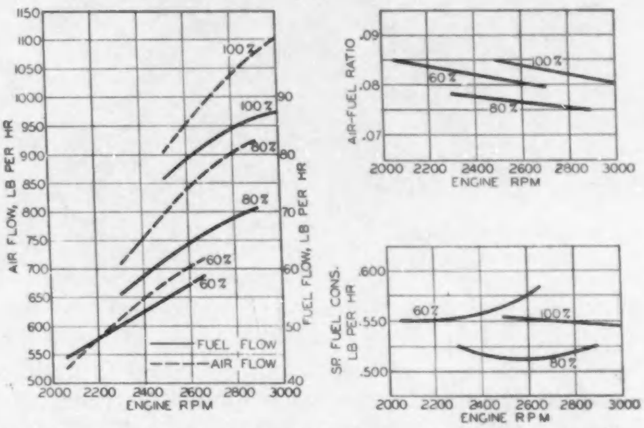

Fig. 8 - Fixed-throttle variable-load effect on fuel-air ratio—Franklin 6AL-335 engine

formance with a direct linkage between the fuel and air throttles, and particularly about performance with variable-pitch propeller equipped engines. Fig. 8 shows locked-throttle performance with a fixed linkage between fuel and air, speed variation being obtained by varying the dynamometer load. At 80% power, normally considered a cruising speed, the fuel-air ratio varies from 0.075 at 2900 rpm to 0.078 at 2300 rpm. It can also be seen that the slope of the actual fuel and air consumption curves correspond within reasonable limits.

Tests showed that at speeds of 2600 rpm and 2360, corresponding to 80 and 60% power, injected fuel delivery drops 12% with a temperature rise from 80 F to 130 F. Above this temperature engine performance becomes erratic and unsatisfactory. This condition is apparently caused by cavitation in the supply line and at the supply pump inlet. Since fuel supply temperatures in excess of 130 F are common, it may be necessary to use a booster pump at the fuel tank, as is now being done on large aircraft, unless some means is found to eliminate this cavitation.

Performance Advantages

The advantages this system offers small aircraft engines are:

1. Complete elimination of manifold icing, which is an inherent characteristic of cylinder, port, or manifold injection, as fuel atomization and final vaporization take place where heat for vaporization is always present.

2. Good engine idling characteristics, as uni-

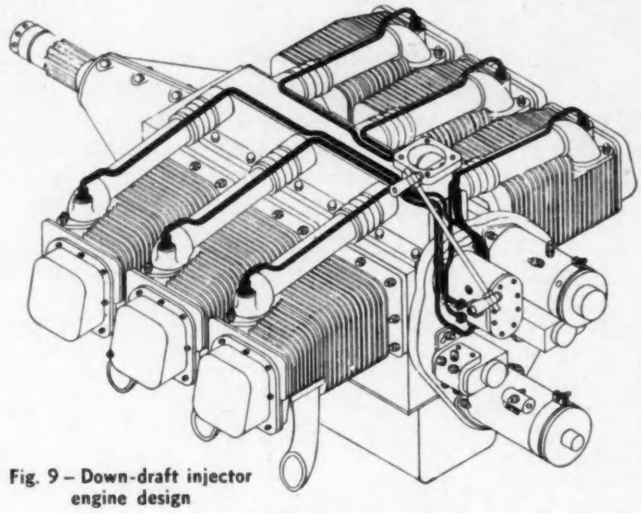

Fig. 9 – Down-draft injector engine design

form distribution of fuel to all cylinders is maintained even with the minimum quantities required for engine idle.

3. Good engine acceleration, which is gained with fuel injection because the mixing of fuel with air takes place at the engine cylinder. When fuel and air are mixed and vaporized in the manifold piping, a certain amount of fuel condenses on manifold walls, causing acceleration to lag.

4. Lower maximum cylinder-head temperatures.

5. Better fuel economy because more uniform fuel distribution obtained with fuel injection permits engine operation with leaner mixtures without danger of overheating individual cylinders.

6. Increased engine horsepower because the engine can be operated with higher average cylinder-head temperatures, higher absolute manifold pressure, and a cooler induction system. Good full-throttle operation is obtained with ½-in. manifold pressure drop, as compared to 1½-in. drop recommended for best carburetor engine operation.

7. Longer engine life between overhauls, because reduced maximum cylinder-head temperatures increase valve, piston, and piston-ring life.

8. Simplified engine cooling, because lower cylinder-head temperatures simplify baffling required for adequate engine cooling.

9. Flatter engine designs. (See Fig. 9.)

Engine Design

Fig. 9 illustrates an ideal injector engine. We recommend the following rules for injector equipped engine design:

1. Design manifold for minimum pressure drop and still maintain throttling control over air requirements.

2. Design engines and intake manifold to keep temperature rise of inducted air as low as possible.

3. Design to keep engine radiant and cooling air heat away from fuel discharge lines.

4. Design for relatively short and direct linkage between fuel pump and air throttle.

5. Mount pump where cooling air can be readily supplied.

6. Keep fuel discharge line lengths to a minimum.

7. Provide a nozzle location in intake manifold or cylinder-head port so that nozzle is 2 in. from intake valve and spraying directly into airstream. This position gives better cold-weather starting.

8. With this design the air filter can be located under the engine cowling, which will reduce the amount of dust reaching the filter when the plane is on the ground. This may be important on planes used in rural areas.

The performance of injector-equipped engines is greatly influenced by the plane's fuel system. The elements of a good fuel system are shown in Fig. 10. This system represents the simplest possible design and, in general, any variation is a modification required to suit a particular airplane.

General rules for designing fuel systems are:

1. Use adequate lines. For engines up to 150 hp, ⅜-in. lines should be used and synthetic rubber hose is recommended from fire wall to pump.

2. Keep restrictions in fuel supply line to a minimum. Sharp bends or turns must be avoided and the gasoline strainer should be located below the fuel tank level for all attitudes of flight.

3. Shield fuel lines and gasoline strainer from engine radiant and cooling air heat.

4. Avoid unnecessary restrictions in return line to fuel tank. Excessive back pressure will affect pump calibration.

5. Avoid loops in supply line that may act as air traps or pockets.

To a great extent the type of fuel system selected is dependent upon the particular plane and upon the preferences and facilities of the plane manufacturer. It is recommended, however, that any fuel system selected be thoroughly tested under all normal operating conditions.

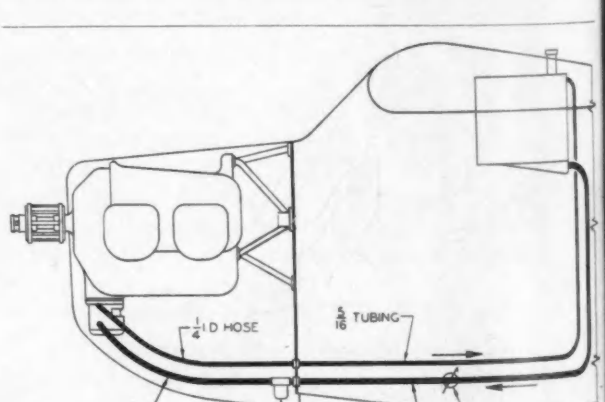

Fig. 10 – Piping diagram of single fuselage tank fuel system

Maintenance of Heavy-Duty Diesel Trucks

EXCERPTS FROM A PAPER* BY **H. E. LARSON**
Pacific Intermountain Express

WHEN this company came under the present management all service work was done from memory or somebody's notebook. The first thing the new management tackled was the setting up of a system of records and a program to prevent costly road failures.

Records

They made up an equipment register sheet, which gives complete data on each piece of equipment. They also set up a service record sheet, which denotes the service work to be done and the service work already done. Through this record the service work is figured ahead of time.

To know the exact working condition of a truck, they set up a driver's trip report. Each driver is required to check the emergency equipment at the start and the end of the run. He must check the equipment to the next driver, and any equipment lost is chargeable to the driver responsible at the time. We realize the drivers are the ones who really know the working condition of our trucks, so we provide a space for their personal reports.

We have a tire service record for each piece of equipment. It shows the equipment number, tire number, location of each tire on that unit and the tire changes on that unit, the date, and the reason for its removal.

By keeping these records we have a complete life history of each unit, and we can check back on anything to see how it has been holding up in service.

Engine Work

We have a substantial supply of spares for everything. We recondition around 15 or 20 heads at a time. We rebuild on a production basis. We have been bringing trucks in for a frame overhaul at 70,000 miles but records show that we are going to be able to step that mileage up to 80,000 miles. When a truck has reached the period of a frame overhaul it is driven into our shop, and the first step is to drop the pan and check the throws. If these show less than 0.004 wear then the engine is framed. If the crankshaft has more than 0.004 wear or a flat spot then the engine is replaced by a rebuilt engine. When we frame overhaul an engine the sleeves, pistons, heads, and upper rockers are replaced. The fuel pump and injectors are recalibrated. The covers on the transmission are pulled and the transmission is checked. Differentials are checked. The engine is then rebuilt of reconditioned heads, sleeves, rods, pistons, and rocker cages. The condition of the crankshaft denotes just what the job is to be. We sometimes get two or three frame overhauls on an engine before it has to be rebuilt completely.

After removal the engine is completely dismantled and attached to a wagon, which is pulled to the steam rack, where the parts are removed, with the exception of the block and crankshaft, to be steam cleaned. After cleaning, the parts are returned to the engine shop.

Here the compressor, heads, starter, and so forth are turned over to the mechanics for reconditioning. The block is put on a stand built to hold it in an upside down position.

While in this position it is checked for cracks and it is cleaned of all scale, rust, and carbon. Next it is checked for alignment by placing a mandrel that is machined 0.001 smaller than the bore for the main bearing shells. The main bearing caps are then pulled with a torque of 310 ft-lb or the angle setting, whichever is required. If the mandrel can be removed, then we know the block is not warped. If it cannot be, then we blue the mandrel to see where the misalignment is. If it would take welding and machine work to fix the block we discard it, as then it would cost about the same as a new block by the time it was fit to use. New camshaft bushings are installed. A camshaft that has

* "Maintenance of Heavy-Duty Diesel Trucks on Highways," was presented at Southern California Section of the SAE, Los Angeles, Nov. 14, 1946.

been thoroughly checked is installed. A reground crankshaft is fitted into the block, which is turned over for installation of sleeves. Then the engine is installed with pistons and connecting rods.

The lower cam followers are next installed; push-rods are put in place; and the engine is ready to have the timing checked.

Check for Flaws

In the process of rebuilding the parts, the crankshaft, camshaft, pistons, rods, and so forth, are checked for flaws. Pistons, sleeves, and the like, are blasted with walnut shells to remove rust, carbon, and scale. Rods are checked for alignment and to see if they are out of round. If they are out of round, the caps are removed and ground square with the rod. Then the caps are bolted back on with 110 ft-lb or the angle setting, whichever is required, and ground square. The rod is then taken to this grinder where, with special tools and jigs, the hole is reground to factory specifications. The bushing is then pressed from the rod and a new semifinished bushing pressed in. Next this rod is taken to the boring bar, which bores out the bushing to fit the wristpin. This boring bar puts the two holes in perfect alignment and within minus 0.005 of the exact distance of 12 in. recommended by factory specifications. If the rod has a slight twist in it the boring bar aligns the two holes but if the rod is twisted badly we do not attempt to straighten it. After the rod is bored it is taken to the rod checking tool to check for misalignment or wrong boring of the hole. Then the rods are balanced to within 1/4 oz of each other.

Sleeves are bored to the oversizes of 0.020, 0.040, and 0.060.

Heads are checked for cracks and checks. All soft plugs are removed. All scale, rust, and carbon are removed by blasting. All seats are checked, and any worn, loose, or cracked ones are replaced. All injector coppers are checked, and are replaced, if bad. Records and observations have proved that thorough cleaning of rust, scale, and carbon has eliminated most of our road failures. Valve springs are checked for proper tension. Valves are refaced or replaced with new valves. The head is then assembled and put into stock.

Upper rocker cages are dismantled and the rockers rebushed if necessary. If the shafts show wear, they are chrome plated. Oil holes are checked to make sure of the proper circulation of oil and the injector tips are checked. The adjusting nut and screw are checked for binding and stripping. Then the rocker cage is assembled and placed in stock.

The lower cam followers are dismantled and all bushings replaced if needed. The shafts are checked and replaced if worn. The pins and rollers are removed and the pocket of each follower built up by welding with bronze. It is then placed on a special jig and bored out to a distance 0.065 higher than when new. The pins and rollers are replaced. The unit is then assembled and taken to stock.

We have designed a fuel pump checking stand, which consists of a 5-hp electric motor, variable-speed pulleys, reserve fuel oil tank, two oil filters, 12 fuel supply tubes rebuilt to our needs, tachometer, and counter that counts rpm. The rack where the pump is bolted on can be turned by this crank to facilitate easy handling and installing of the pump. When a fuel pump goes bad it is brought here and dismantled completely, cleaned, and all worn parts replaced.

While the pump is down we install a little locking device of our own making because we had a lot of trouble at one time, due to drivers who thought they could increase the zip in the engine by increasing the amount of fuel it was getting.

We have an air bench where all parts connected to the air system are repaired and checked. Each part after rebuilding can be checked for proper operation as if it were installed on the truck. This system operates the same as the braking system on a truck.

For the rebuilding of transmissions and differentials we built two special stands and the fittings to hold them. The transmissions or differentials are set in these stands and can easily be tilted to any position and locked to facilitate ease in repairing. They are completely torn down, cleaned, worn parts replaced, then assembled and adjusted.

Refrigeration Unit

During the war we designed and built our own refrigeration unit. This unit was built completely of iron, making it large and very heavy. Six belts were connected to the motor, providing the driving power.

Just before the war was over we set about to design the type of unit we really wanted. This unit is direct driven with only one belt to drive the generator. The unit consists of condenser, AC4, Wisconsin aircooled engine, centrifugal clutch, flexible drive coupling, carrier compresser, and a flyweight tank. The cage, castings, doors, and coverings are all made of aluminum. Condenser and coil are made of aluminum except for the copper tubing. Everything that goes inside the body is constructed of aluminum except the copper tubing and the 1/4-hp electric motor used to turn the blower fans. This unit is 900 lb lighter than the original. A defrosting system has been worked out that sprays water over the coils, thus melting the ice. This can be done from outside the body without opening the doors or disturbing the load. Methylchloride is the only refrigerant used.

We have conducted many tests with this unit under extreme operating conditions and we find that it does an excellent job.

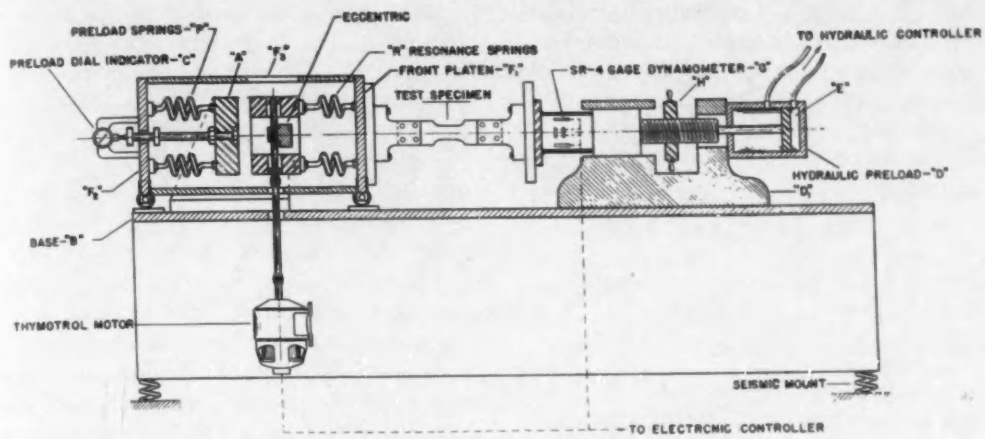

Fig. 1. Sonntag universal fatigue testing machine SF-20U

METALLURGY, ENGINEERING and SPECS

EXCERPTS FROM A PAPER* BY

Francis G. Tatnall Baldwin Locomotive Works

RECURRING experience indicates that if experimental stress figures differ from those arrived at by conventional design formulas based on assumptions fortified by safety factors, the designer can better use the experimental data. This choice means that the work of the engineer is just begun, for the interpretation of the mass of data is more difficult than acquiring them.

Engineers are continually surprised and shocked by unsuspected findings in experimental studies of structures. Some parts prove to be much stronger than necessary, some regions carry no load at all, others are overstrong in push-pull direction but vulnerable in torsion or bending; points of shocking weakness are due to stress concentrations that defied theoretical analysis; the vastly increased endurance is achieved by a little shifting about of cross-section or neutral axes.

This changing the relationship of mass and stiffness, always a first thought in resonance and vibration troubles, is thus effective in static load redistribution too, where strong points prove to be trouble points. Components would better serve as springs in a structure or as local points or yielding to relieve cramping and local high stress levels than as bulwarks of strength.

Here metallurgy contributes something about residual stresses. Metallurgists get their data from testing machined specimens, while engineers get theirs from testing parts. The metallurgist advises what kind of heat treatment or cold work will make the surface try to assume a larger volume than the interior. Surfaces in compression are of no help to materials loaded in straight tension, say metallurgists. But engineers say few parts escape some manner of torsion or bending because tension members are often twisted or bent merely by the elastic deformation of their neighbors.

*Paper "Is There a Relationship Between Metallurgy, Engineering, and Materials Specifications?" was presented at the SAE 1947 Annual Meeting, Jan. 6, 1947.

We are warned that fatigue strength is only one factor in service life. Others are high and low temperatures, corrosion, simultaneous tensile stresses acting in several directions at once, harmful residual stresses and thermal stresses, or heat treatments that gain strength and elasticity at the expense of damping capacity in metals, also factors in service life and each varies as it is influenced by the other.

■

A Definition:

"Stress and strength are related in this manner: *Stress* is what a material sustains from imposed loads; *strength* is what the material can stand. Stress analysis, provided by the engineer, determines only the stress levels in the parts of a structure. Notch sensitivity values, supplied by the metallurgist, determine if those stress levels are dangerous. Finally, the testing engineer proves out the *actual strength* by a life test."

■

Engineers say that if laboratory tests do not develop the same kind of failures that are brought in from the field, these must be revised until they reproduce service failures. Impact tests, micrographs and hardness tests are not enough to deduce the cause of a part failure in the field. When a metallurgist cuts up the failed part to make these tests the engineer says he is only destroying evidence.

If harmful residual stresses, multi-axial stresses, and low temperatures make ductile materials brittle, this is just another way of increasing notch sensitivity – which in turn increases the hazard of high stress levels in a structure.

Damping capacity is the metallurgist's remedy for notch brittleness. This acts in a metal like rubber shock mount. This is the inherent property in a material to develop a mechanical hysteresis loop during a stress cycle which turns vibration into heat. High damping materials, such as cast iron and cold worked metals, are on the low end of the notch brittleness scale because stress concentrations here do not knot up too tightly at the roots of notches, nor do such metals resonate so easily under vibratory conditions, so that lower fatigue endurance limits can be tolerated.

Need Service Load Values

Some say this vibration absorbing capacity, combined with ability to moderate stress concentrations, is due to the multiplicity of internal stresses already existing in these materials, counteracting each other.

Few designers are provided with the values of the measured loads that the structure encounters in service. These can only be had by actually measuring the loads, which prior to certain recent developments, were hard to measure so as to include frequency, amplitude, impacts, occasional overloads, and superimposed vibrations. Now the job is not too difficult using modern electric strain gages and oscillographs.

There are five reasons for making structures stronger by making them lighter:

Improvement in structural efficiency. If a component of, say, 380% design load is connected to one of 90% design load with a connection which tests at 70% design load, you have a poor chain. Wanted: 100% design load all over, *no more, no less.* Factors of safety do not efficiently make up for lack of statically and dynamically measured facts.

Simpler structures, lighter sections, are easier to handle, fabricate, assemble, and maintain. This is possible by scientifically selecting materials (contribution of metallurgy), plus static and dynamic measurements plus intelligent interpretation of masses of data (contribution of engineering), plus performance testing and measurement of service loads (contribution of field staff). A saving of weight up to 30% has been achieved, and an almost equal saving in cost due to simplification.

A more graceful product. The stylist and the aerodynamist help with this. But the old truth still stands: Anything that is right, looks right. When parts of a structure all take their share of the work, the resulting structure looks good.

Economics. If labor demands a greater share of the customers' dollars, and the customer balks at paying more, savings through design improvement is the only unexplored possibility.

Competitive reason. If a competitor steps out in front offering a better product at less cost, there is sufficient incentive to disrupt the *status quo* in starting radically new designs.

Procedure of design improvement varies somewhat but generally it follows this sequence:

Measurement of service loads. Put the existing structure through its paces in service, measuring loads under worst operating conditions. Strain gages and accelerometers connected into 12-element oscillographs recording on moving film is a usual method. The bonded wire resistance strain gage is a method widely used and the technique has been well covered in the papers.

Structural static test. Load the complete existing structure or major components in a testing machine by dead weights, or by hydraulic jacks, or other means. Loading is put on by increments of design load, up through proof load to full design load and sometimes on to failure. See if all parts

are taking their share of the load which flows through the structure like water. See also if they are overdesigned. Strain measurements are made in two principal ways:

(a) Cementing bonded wire resistance strain gages, or others that will do the job, all over the structure and watch the development of the stress pattern while loading by increments. Use equipment which rapidly scans the unbalance of all the parallel electrical bridges of which each gage is a connected part.

(b) By spraying the structure or component with a brittle lacquer which will crack at some reasonable low load. The cracks will appear at right angles to the lines of stress. Then to determine qualitatively these high points of the stress pattern, cement wire strain gages to the points of most intense cracking.

Dynamic or life test. Structural fatigue testing machines are the third tool for engineering testing developed in this new era of measured structures. The principal types are those with mechanical oscillators for inducing alternating forces that are constant throughout the test. Fig. 1 is a schematic diagram of a Sonntag mechanical oscillator, constant alternating force machine. One test simultaneously tests the material, the joint, surface condition, the influence of stress levels and notch sensitivity and picks out stress-raisers. Thus it is a test of both the design and the workmanship. If the failures do not reproduce service failures then restraints and modes of loading must be altered until reproduction is achieved.

Engineering interpretation. Here engineering, metallurgy, and the stylist must get together for best results. At this stage disregarding data because there is too much of it – or because time is too short to use it – is making a bonfire of dollar bills.

Wind tunnel tests and high speed motion pictures. These are important steps. Though essential for aircraft, for automotive and rail equipment these add the finishing touches to a thorough job.

Performance or service test. In aircraft this is called flight testing with telemetering apparatus where strains, accelerations and other data are radioed to the ground. In automotive equipment it is the work done on the proving ground with adequate instrumentation.

Specifications are needed to establish par value for basic materials and to act as a screen to pass or reject within established limits. The specification writer is not a cloistered villain. He is usually the engineer and the metallurgist removed from their environment and grouped into what is called a technical committee.

Despite the nature of the process, materials specifications provide an essential working tool to guide those who must produce within some technical limits, and to those who must decide whether or not they want to accept those materials.

Since, however, we have no method of test to rate human judgment there is no way to establish the real relationship between metallurgy, engineering, and materials specifications. We continue to need the checks and balances of tests and instrumentation.

EMPHASIZE MODE OF STRESS APPLICATION

In discussion of Mr. Tatnall's paper, M. A. Erickson and G. C. Noll, Chrysler Corp., pointed out that the mode of stress application must be known to determine the danger of failure associated with a stress level or magnitude. They pointed out that:

The importance of the mode of stress application arises from the fact that the same material has a different strength for the cases of imposed static stress, reversed stress, and a combination of the two. Conventionally, they pointed out, the ultimate strength as determined by the tensile test is used as the criterion of failure for parts subjected to static stress.

For reversed stress, the endurance limit established by fatigue tests, such as conducted on the rotating beam machines, serves as the criterion. However, for the combination of static and reversed (fluctuating) stress, the strength of the materials is estimated from a Modified Goodman Diagram[1] or corresponding equation.[2]

Significance of these considerations are shown by these examples which show the variation in strength of parts with the mode of stress application:

PART	STATIC STRESS – psi	REVERSED STRESS – psi
Axle shaft[3]	212,000	20,000
Crankshaft[4]	160,000	25,000
Welded joint[5]	62,000	6,200

Thus by using only stress levels in design could result in an error of 90% in strength.

As the author points out, the discussers wrote, low notch sensitivity is associated with high damping capacity in some materials, and as a result damping capacity could conceivably be used to determine the degree of notch sensitivity.

However, it does not necessarily follow that damping capacity is the remedy for notch sensitivity, no more than hardness is a remedy for the tensile strength of steel even though the tensile strength can be associated with hardness within certain limits.

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[1] Smith, J. A., "The Effect of Range of Stress on the Fatigue Strength of Metals," Univ. Illinois Bull., Eng. Exp. Sta. Bull. No. 26, Feb., 1942.

[2] Lipson, C., and Noll, G. C., "Allowable Working Stresses," Proc. SESA, Vol. 3, No. 2, 1946.

[3] Horger, O. J., and Lipson, C. H., "Automotive Rear Axles and Means of Improving their Fatigue Resistance," Proc. ASTM, Vol. 46, 1946.

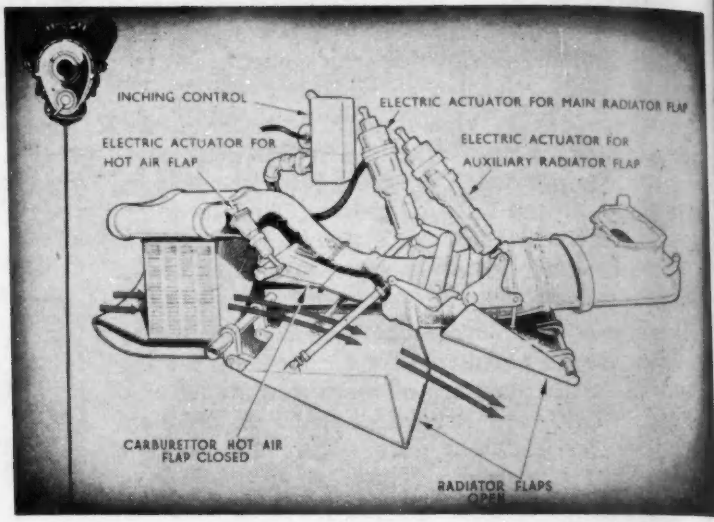
[4] Williams, C. G., and Brown, J. S., "Fatigue Strength of Crankshafts," Engineering, July 17, 1842.

[5] Karpov, A. V., "Fatigue Problems in Structural Designs," Metals & Alloys, Dec. 1939.

LIQUID-COOLED AIRCRAFT ENGINES SUITED TO

Good Heat Dissipation Condenses Power Package

Digest of paper
By J. D. PEARSON
and E. WARLOW-DAVIES
Rolls-Royce Limited



LIQUID-COOLED aircraft engines offer special features that cannot be overlooked in modern air transport work, Pearson and Warlow-Davies advise. They contend that:

Principal limitation to power produced by a given size engine is the rate of heat removal from cylinder walls and heads. Liquid cooling dissipates heat at a much higher rate than air cooling. A properly designed liquid-cooled engine will give high powers in proportion to its size and – unlike air-cooled powerplants – exhibit extremely good detonation characteristics at high weak-mixture cruising powers.

A most important point is that the temperature of the circulating coolant can be automatically controlled within predetermined limits. Separation of the engine itself from the cooling surfaces – which dissipate engine heat – gives greater design freedom in both the engine and the installation. Coolant radiators can be located at any convenient place in the airplane.

Heat-dissipating surfaces are independent of the engine. Their frontal area can be arranged to suit the airplane's speed. Examples of a liquid-cooled installation's suitability to climatic conditions are shown in Fig. 1.

Arrangement on the left shows how the heat-dissipating surfaces can be made large enough to suit tropical requirements without modifying the engine. Shown in the left of Fig. 1 is how heat-dissipating surfaces, under arctic conditions, can be readily reduced to meet needs of extremely low temperatures.

To insure adequate cooling on the ground, heat-dissipating surfaces can be placed in the propeller slipstream, as in Fig. 2.

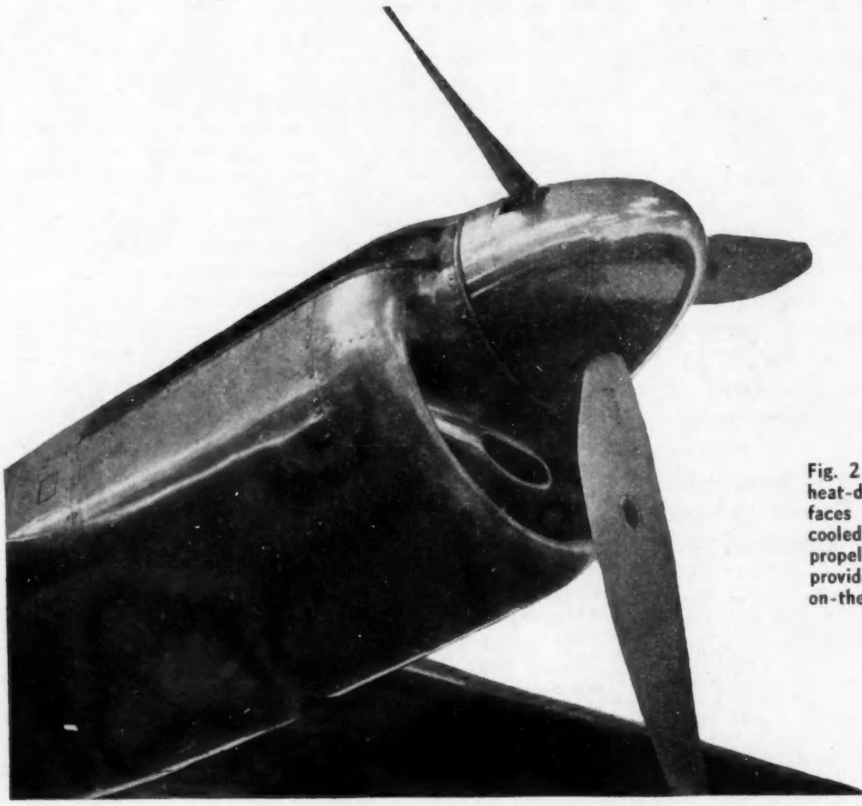


Fig. 2 – Locating the heat-dissipating surfaces of a liquid-cooled engine in the propeller slipstream provides adequate on-the-ground cooling

COMMERCIAL TRANSPORT

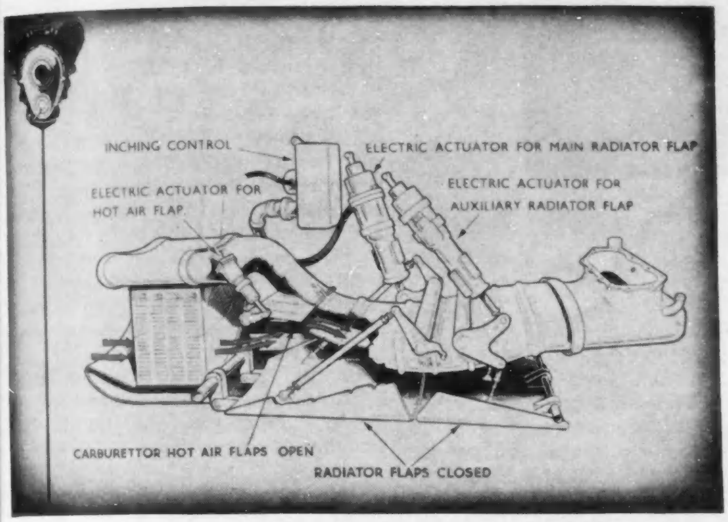


Fig. 1 – Without altering the engine itself, liquid-cooled installations can be adapted to tropical conditions, as at left, or arctic conditions, as at right, by simply changing the area of the heat-dissipating surfaces

For a given take-off power, the liquid-cooled engine offers a number of advantages. Very high emergency power – such as a rapid climb over icing conditions – can be had for short periods. Highly economical continuous cruising power for high air speed also is available. The engine is completely free of detonation in the cruising range under all atmospheric conditions.

Oil consumption is as low as 2 to 4 pt per hr, 20 gal being ample for a transatlantic crossing.

Small Package – High BMEP

Since liquid cooling produces high powers from a small engine package, such a powerplant will operate at relatively high piston speeds and mean effective pressures. High mechanical reliability is attainable under such conditions provided the design is sound. Military experience proved that careful attention to detail pays off in reliability.

Tailoring a liquid-cooled engine to air transport requirements will repay the airline industry with increased economy and flexibility of operation. (Paper entitled "Liquid-Cooled Engine Powerplants for Transport Aircraft," presented at SAE National Air Transport Engineering Meeting, Chicago, Dec. 2, 1946.)

Highlights Progress In Tire Development

Digest of paper

By A. N. CARLETON

Fisk Tire Co.

FROM the first balloon tires to present-day synthetics, tire engineering has kept pace with demands of automotive vehicle manufacturers, declares Carleton. He points out that:

Among the milestones in tire development are:

1. Heat-resistant cord,
2. Stronger and cheaper carcass,
3. Wear-resistant treads,
4. Silent and anti-skid treads,
5. Improved rubber compounds, and
6. High-quality synthetic tubes.

Rayon was found to be superior to cotton cord since it did not deteriorate under heat. Also rayon required less cushion between plies to prevent ply separation. Nylon, woven glass, and steel wire presently exhibit highly desirable cord properties. Wire-cord tires under development assure adequate carcass strength with two and four plies instead of ten, twelve, sixteen, or twenty plies.

Early tires were built to shape on an iron core. Layer thickness had to be right since there was no clearance in the curing mold for the assembled tire with the core in place. Plies were made of square woven fabric, cut at 45 deg, on which was calendered the ply coat.

Tires so constructed did not have required carcass strength, were hard riding, and were high-pressure tires.

New tire-building methods, including cord plies instead of square woven fabric, strengthened the carcass and reduced tire cost.

The tread protects the carcass and resists wear. Designing treads narrower and flatter placed more rubber on the road and reduced load per square inch. This lengthened tire life, lessened the heat build-up, and made for less steering effort.

Tire noise on the straight-away, on turns, and during braking was silenced by redesigning the tread. High and low pitch noises caused by the skid design were overcome with a skid design that broke up the sound wave length. Skid designs also were perfected to eject small stones and prevent aggravated noises.

Rubber compounds were developed to withstand heat, abrasion, separation, and other factors detrimental to tire life. Accelerators give the best combination of modulus, tensile strength, and elongation. . . . Antioxidants prevent oxidation. . . . Carbon black improves tread wear. . . . New mixing equipment and compounding techniques properly disperse the carbon black and prolong tread life.

Emerging from rubber crisis during the war is a tube rubber that rivals the natural rubber product. Butyl (GR-1) has the advantage of retaining air many times longer than rubber. It also resists high-temperature build-up – a cause of early tube failure in heavy service tubes.

Present developments show promise of achieving still better-wearing and better-riding tires. (Paper "Tire Development – Present and Future," was presented at the SAE New England Section, on Jan. 7, 1947.)

Specific Heats for Gas-Turbine Media

By DR. NEWMAN A. HALL

United Aircraft Corp.

(This paper will be printed in full in SAE Quarterly Transactions)

CHARTS of mean specific heats simplify calculations on the working media in steady-flow processes such as gas-turbine cycles. Dr. Hall presents a chart of mean specific heats for temperature changes in the range from

Concluded on p. 60

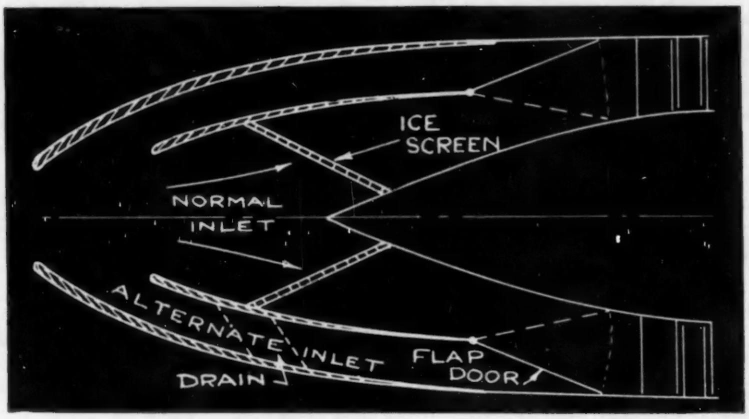


Fig. 1 – This appears to be an effective anti-icing development for aircraft gas turbines

Turbine Allergic To Water and Dust

Digest of paper

By A. DOLINSKY and F. W. DISCH

Boeing Aircraft Co.

(This paper will be published in full in SAE Quarterly Transactions)

FILTERING foreign particles from gas turbine intake air will pay dividends in better performance and longer life, Disch and Dolinsky observe. Pointing out the possible troubles and cures they show that:

Along with all-important oxygen provided by the atmosphere, the aircraft turbine inhales water and solids that do it no good. They accelerate wear of parts and reduction of power efficiency.

During ground operation and take-off, impact of dirt, stones, and gravel erodes and damages compressor and turbine blading. Water and abrasive sand and dust play the same kind of havoc.

Ice particles, hail, and sleet damage compressor blading. Inlet icing unbalances compressor inlet air distribution. Salt and chemicals suspended in the air corrode blading. Unequal cooling of ingested water on compressor components causes rubbing of parts with close tolerances.

Ground running gas turbines also results in an oil-and-dirt coating baked on blades. This changes air foil characteristics, tantamount to a power loss due to decreased compressor efficiency.

Simplest way of excluding foreign matter from the aircraft gas turbine is with an external separating-type inlet to deflect the air stream and foreign particles. A flush type of engine air inlet should then be located behind the separator.

Internal inertia type of separation is attractive for induction systems submerged in the fuselage. An ejector slot to discharge the foreign matter must be provided. This type of separation is desirable because it prevents, rather than eliminates, troubles.

Both external and internal separators are designed with anti-icing provisions. A promising anti-icing arrangement is shown in Fig. 1. Air normally enters the center duct and passes through an ice screen. Ram pressure keeps the flap doors in the closed position, shown by the solid lines. When the screen ices, the air flows through the alternate annular duct and forces the trap doors to open.

Considering these preventive measures during, not after, design insures best results. (Paper, "The Atmosphere and Its Predicted Effects on Turbine Type Aircraft Engines," was presented at SAE Annual Meeting on Jan. 7, 1947.)

Engine Performance Predicted by Charts

Digest of paper

By RAY E. BOLZ

National Advisory Committee for Aeronautics

(This paper will be published in full in SAE Quarterly Transactions)

PERFORMANCE of a jet engine or any of its major components can be predicted from a series of charts presented in this paper. Operation throughout a large range of operating and engine variables is covered for engines of typical dimensions. Charts are applicable to both compressor-turbine jet engines and to ram-jet engines. The authors note that:

Among the performance characteristics which can be determined are specific thrust; thrust specific fuel consumption; specific power; and overall, thermal, and propulsive efficiencies. Required cross-sectional areas at the engine inlet and nozzle outlet are also indicated. The curves provide a history of the pressure, temperature, and Mach number of the working medium from compressor inlet to nozzle outlet.

The analysis takes into account adiabatic efficiencies of compressor and turbine; and diffuser, combustion, and nozzle efficiencies as well as momentum pressure loss in the combustion chamber (assuming a chamber of constant cross-section).

Relationships between airflow, pressure ratio, and efficiency for compressor and turbine depend on design characteristics of the particular engine and are not predicted by these graphs. Nor is combustion efficiency predictable. Values of these characteristics for the optimum design can be found by varying them over their ranges and tracing results on the charts.

(Paper "Graphical Solution for the Performance of Continuous-Flow Jet Engines" was presented at the SAE Summer Meeting, June 6, 1946.)

Specific Heats

cont. from p. 59

400 to 5000 R. In his discussion, he relates:

This is a convenience designed for the engineer who prefers to express heat and work in the familiar terms of temperature, pressure, and specific heat without introducing enthalpy, entropy, and internal energy.

A basic chart gives the mean specific heats for dry air. Additional charts provide correction factors to account for the presence of water vapor, fuel vapor, and burned products of combustion in the air.

Arithmetic specific heats are plotted for use in correlating energy transfer and transformation with temperature change, where specific heat appears as a coefficient in almost all equations. This is a constant pressure specific heat as required by the temperature change.

Analysis of compression and expansion processes involves use of specific heats in an exponential function. Curves of logarithmic specific heat are supplied for these processes. Values of the two specific heats, arithmetic and logarithmic, vary significantly at large temperature differences.

Development of the charts from thermodynamic principles is outlined in appendices. (Paper, "Mean Specific Heats for the Working Media of Gas Turbine Powerplants," was presented at SAE Annual Meeting, Jan. 7, 1947.)

Inlet Conditions Affect Combustion

Digest of paper

By J. HOWARD CHILDS
RICHARD J. McCAFFERTY and
OAKLEY W. SURINE

National Advisory Committee for Aeronautics

(This paper will be published in full in SAE Quarterly Transactions)

HIGH inlet temperatures and pressures and low inlet velocities are prerequisites of good combustion in a turbojet-engine combustor according to these authors.

Work done at the NACA Cleveland Laboratory with the annular combustor of an early Westinghouse 19B engine shows that unfavorable inlet conditions are the basis of altitude operational limits. Messrs. Childs, McCafferty, and Surine report that:

Combustion appears to be sensitive to inlet-air temperature, pressure, and velocity. Each of these parameters was varied independently at simulated conditions of 10,000 rpm and 16,600 ft, and 15,500 rpm and 24,000 ft. Over a range of fuel-air ratios, low combustor-inlet temperatures and pressures and high combustor-inlet velocities produced faulty combustion. Resonance developed, and combustion efficiency decreased. Both the maximum temperature rise obtainable and the fuel-air ratio at which it occurred decreased as the inlet conditions became more adverse.

Altitude operational limits were explored by simulating climb. The effects were similar to altering inlet conditions in an unfavorable direction. These results, plus data from the Bureau of Aeronautics revealing that with higher altitudes lower combustor-inlet temperatures and pressures and higher velocities can be expected, lead to the conclusion that latitude operational limits are due to unfavorable inlet conditions.

Tests were run of seven engine speeds from 5000 to 16,000 rpm at conditions equivalent to 20,000-ft altitude. In a "dead band," between 6500 and 10,000 rpm, temperature rise fell below that required by the engine. Blowout occurred at 8000 and 10,000 rpm. This nonoperational range can be explained as a region where the adverse effect of increasing inlet velocity overbalances the beneficial increasing temperatures and pressures.

These wind-tunnel tests, using both AN-FF-22 and AN-F-28 fuels, were made with the combustor only and inlet and outlet ducts corresponding to the passages of the engine. Plots of operational limits obtained this way agree closely with those obtained using a complete engine in the wind tunnel. (Paper "Effect of Combustor-Inlet Conditions on Combustion in a Turbo-Jet Engine" was presented at SAE National Aeronautic (Autumn) Meeting on Oct. 3, 1946)

■ ■

Tie Engine Oil Type To Filter Efficiency

Digest of paper

By OSCAR C. BRIDGEMAN
and ELIZABETH W. ALDRICH
Phillips Petroleum Co.

and J. B. ROMANS
National Bureau of Standards

(This paper will be published in full in SAE Quarterly Transactions)

OIL filtering is a complex problem, solution of individual cases hinging upon the filter and detergent-oil relationship, Bridgeman, Aldrich, and Romans disclose. From their studies with 20 different oil filters and several lubricants, they conclude that:

Filtering efficiency of a given oil filter varies widely with different types of detergent oils. But for each combination of filter material and oil additive, filter efficiency is specific.

One problem encountered in filtering detergent oils is the removal of the detergent additive from the oil by the filter. Since oil refiners produce detergent-type oils with proper additive concentration for overall heavy-duty service, any marked removal of detergent additive in service may impair the oil's performance.

These investigations suggest that detergent additives are filtered out of heavy-duty oils in two ways: (1) direct adsorption of the additive material by the filtering medium and (2) removal of insoluble material containing adsorbed additive. While all oil filters show direct detergent adsorption to some degree, the amount for each filter material-and-additive combination is fairly constant.

Variation in percentage of detergent additive removed from several oils in a series of tests with activitated clay filtering material is shown in Fig. 1. The range is seen to be from 18% to 100%.

These investigations pointed out the variables involved in filtering heavy-duty oils. Further study is needed on factors such as the filtration of charged sludge particles in oil, and filter effect on removal of nonmetallic additives. (Paper, "Oil Filters and Detergent Oils," was presented at SAE National Fuels & Lubricants Meeting, Tulsa, on Nov. 8, 1946.)

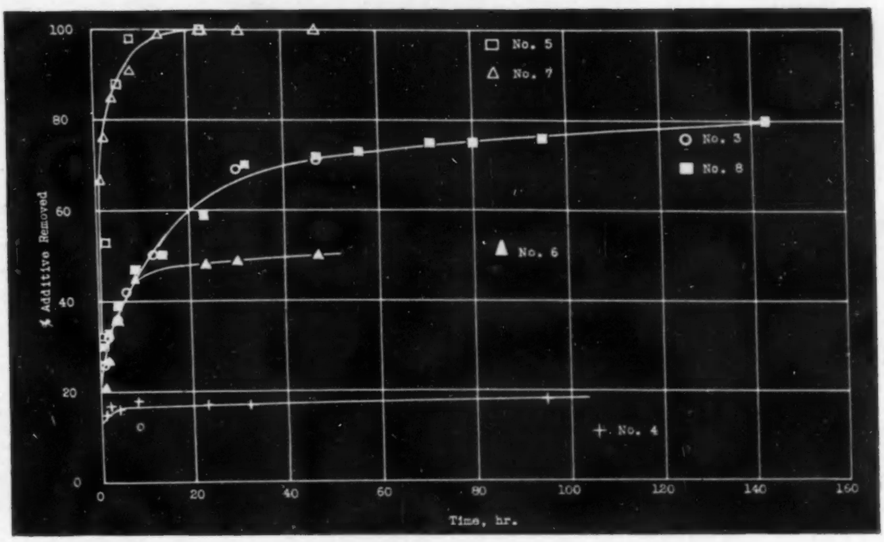


Fig. 1 – Tests with various oils filtered through activated clay filtering material showed a wide spread in the percentage of detergent removed. It varied from a low of 18% for one oil to 100% for another

Corrosion Causes Most Cylinder Wear

Digest of paper

By CLARENCE S. BRUCE
and JESSE T. DUCK
National Bureau of Standards

MOST cylinder wear resulting from normal operation of an automobile is due to some form of corrosion – the corrosion probably occurring during warmup. Discussing both conclusions and test setup in their paper, the authors say that:

Maximum wear occurred at the combustion end of the cylinder at levels where the rings repeatedly remove both oil and corrosion films. Various studies have shown that the corrosion film formed on iron protects the surface from further corrosion. It is reasoned that after combustion, corrosive gases condense on the cylinder walls and attack the surface. On the next stroke, piston rings wipe the walls clean of corroded material as well as oil, preparing for more corrosion.

Low cylinder-wall temperatures favor condensation and, therefore, corrosion. The finding that greater wear occurred with low cooling-water temperatures supports the corrosion-wear theory and indicates that corrosion is most likely to occur during warmup, when temperatures are low.

Measurement of cylinder wear was made using a method developed by the National Bureau of Standards as an improvement over micrometer measuring. Indentations are formed in the cylinder wall with a precisely shaped diamond indenting tool. Length of the indentation is accurately measured by a special microscope. From the observed length, the depth can be computed. The amount of wear at any given point is reckoned as the difference in the computed depths before and after a period of operation. (Paper "Minute Amounts of Cylinder Wear Are Measured with a Microscope" was presented at SAE Annual Meeting, Jan. 10, 1947)

Vehicle Tests Yield Operational Results

Excerpts from paper

By PAUL OBERREUTTER
Mid-West Dynamometer & Engineering Co.

CHASSIS dynamometer soon will be a common piece of equipment for fleet operators for checking power and economy of cars, light trucks and buses. It is ideal for locating troubles which show up only under load or speed. The vehicle can be driven on the chassis stand at the speed or load at which trouble appears, thus giving a practical means of correcting the difficulty. In tune-up work, its advantages are for setting the timing for maximum power for the grade of fuel used, checking A/F ratio with an exhaust gas analyzer, and checking whether the engine is developing enough power. It also makes possible other adjustments necessary for satisfactory performance. Fleet operators usually have an accurate record of operation and fuel economy of their equipment. But the chassis test dynamometer makes possible quick checking and rectifying of troubles that develop.

Equipment has adequate capacity for testing maximum high-gear power of all automobiles, small trucks and buses. The absorbing unit is a hydraulic dynamometer. Size of the unit depends upon the application. Water system is a closed power absorption setup; load is determined by the amount of water in the dynamometer. Under such a system, the road load remains constant until the operator changes the setting by remote control.

Entire power performance is reflected in horsepower delivered to the rear wheels. Normal practical operating speeds are from 10 to 70 mph. Floor space required for a stationary installation is about 5 to 6 ft longer than vehicle length, and about 10 ft wide. Portable mounted equipment can be furnished, but for heavier duty work a stationary job probably would be much more suitable. In case of general motor overhauls and major repairs to engines for which they must be removed from the chassis, it is my opinion that a block test dynamometer installation for full testing of engine alone would be very desirable. (Paper, "The Dynamometer as an Aid in Fleet Maintenance," presented at SAE National T&M Meeting, Chicago, Oct. 17, 1946.)

■ ■

Links Transmission To Truck Efficiency

Digest of paper

By JULIUS GAUSSOIN
Silver Eagle Co.

TRUCK engines geared to a well-designed combination transmission will deliver high horsepower at efficient speeds, claims Gaussoin. Describing what he considers the ideal arrangement, he points out that:

One unit (called the range transmission) will provide three forward speeds – starting, mountain, and road range – and a reverse. Providing an insufficient number of steps, it should be supplemented with an auxiliary or speed selector, of several closely-spaced ratios, placed in front of the range transmission. This gives the combined unit four or five correctly-spaced forward speeds.

Great advantage of this road-ranger transmission is the ease of adapting it to trucks for different kinds of work or operating conditions. The speed selector can be changed to an overdrive or extra low gear without touching the basic range increments.

Simply changing one pair of gears in the speed-selector transmission would adapt the combination to any kind of service. Costly and wasteful modification, such as changing of transmissions, adapting driving lines, changing cross members to fit, or installing special rear-axle ratios, can be eliminated.

Besides its versatility, the road ranger would be successful because:

1. Stresses will be lower in both transmissions. Total gear reduction in the speed selector will be only about 2 to 1 compared to gear reductions of up to 8 to 1 in conventional transmissions.

2. The speed selector will be lighter and shift easier since the lesser reductions permit use of smaller gears and closer shafts.

3. Driver shifting troubles will be minimized because the road ranger shifts easily and has no gear-splitting.

4. Hazardous double-shifting is eliminated.

5. It would make for minimum engine lugging and shocks to driving members of the truck.

6. Gears would wear uniformly.

Given the correct gear ratios in uniform steps, the truck provided with the road ranger will live long and do the work for which it was designed. (Paper, entitled "A Stairway for the Highway," was presented at the SAE Northwest Section on March 1, 1946.)

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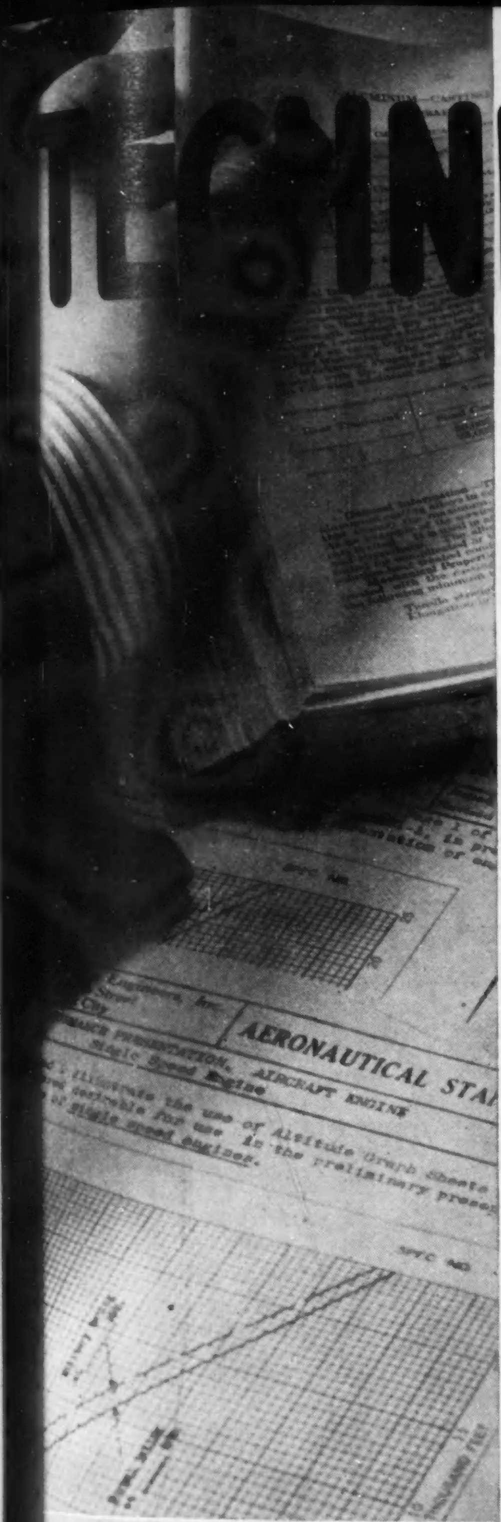


TECHNICAL COMMITTEE PROGRESS

SAE Group to Code Standard Aero Parts For Simplified Usage

A new coding system for SAE Aeronautical Standard parts will give each part a specific number to simplify procurement, stocking, and cataloguing. Existing references to drawing numbers in the design standards will be retained in the improved system, being developed by the newly-created SAE Standard Parts Committee of the Aeronautical Committee.

The individual designation which the proposed code will give to each part will distinguish dimensional and other differences between similar units. The present AS system identifies a part as to type or class, but does not differentiate between similar parts of varying dimensions.

For example, AS 36 gives dimensions for 11 different plain-washer sizes. Yet no one washer has a specific number of its own. Under the proposed coding, each of these 11 washers will be given an individual number-designation based on an arrangement of letters and numbers.

Coding a standards item is just as important as specifying its dimensions. Development of SAE oil viscosity ratings, for example, without labelling each kind would have greatly complicated each service station oil-purchasing transaction, to say nothing of the problems heaped on the refiners.

Here is just one way the AS code will streamline industry operations:

Under the present system, each manufacturer must prepare his own drawings of AS parts ordered from a supplier. With coded parts, the manufacturer will have only to order any AS part by its number without submitting any drawings.

Consideration is being given to paralleling the AN code in developing the SAE system.

Allied to the coding program is a plan to designate on the part itself, with a symbol, any special feature or property it may possess. For example, a bolt for use in high-temperature operation might

have a star on its head to distinguish it from bolts of the same dimension, suitable only for ordinary applications.

Such physical identification on the part itself would minimize shop errors in stocking and assembly as well as servicing errors in the field.

While in the past SAE Aeronautical Standards for parts such as bolts, nuts, and rivets were developed by individual committees interested in these

W. P. ENGLISH

Chairman of Aeronautical Standard Parts Committee E-25

specific projects, this new group will function on such an overall program in coordination with other committees.

Chairman W. P. English, Ranger Aircraft Engines, reports that the Committee has agreed to a policy of developing standards only for those items for which material and quality can be (1) readily determined; (2) fully defined, and (3) controlled either on a standard drawing or a referenced specification.

Serving with Chairman English on the Standard Parts Committee are: E. P. Hill, Allison Division, GMC; M. E. Mills, Wright Aeronautical Corp.; F. H. Norriss, Westinghouse Electric Corp.; D. Secord, Pratt & Whitney Aircraft; R. L. Keene, General Electric Co.; E. P. Riley, Thompson Products, Inc., and W. F. Burrows, Aircooled Motors, Inc.

Urge Engine Tailored To Helicopter Needs

To be entirely successful in a helicopter, an engine needs different characteristics than in an airplane, says a recent SAE Helicopter Committee report which details desirable characteristics for a helicopter engine.

Recognizing that helicopter volume doesn't yet warrant a special powerplant, Aeronautical Information Report No. 16, Desirable Characteristics for Helicopter Engines, is a guide for designers at such time as special helicopter engines become commercially feasible.

The report calls attention to:

1. Power and speed relations;
2. Engine loads;
3. Cooling, and
4. Physical characteristics.

A helicopter – like an airplane – requires a 5-min take-off power rating for initial climb, checking descent, and emergency conditions, says the report. Normal rated power (maximum continuous) is used for all other operations requiring maximum power, such as climbing, hovering, and high speed.

A cruising power of 50-80% of normal rated power is desired at 85-95% of normal rated speed.

Engine rpm increasing with altitude in proportion to $\sqrt{\frac{\rho_0}{\rho}}$ would help prevent rotor-blade stall. On this basis, the engine speed rating should be at least 110% of normal rated rpm at sea level.

In the section on engine loads, the report states that minimum fly wheel requirements should be consistent with good idling characteristics down to 20-50% of maximum speed. This facilitates rotor clutch engagement and rotor acceleration.

Helicopter manufacturers anticipate an engine furnished complete as a self-cooling power package – including the fan and oil cooler. But designers are urged to make the engine unit easy to get at and into.

In the fourth section, physical considerations, the report campaigns for compactness in at least one overall dimension. The engine should be designed for mounting in any attitude – from a vertical to a horizontal position of the crankshaft – with minimum alterations.

A flat front face on the engine is desirable for mounting a clutch and transmission. The design should permit attaching the engine mount on this face.

Since thrust loads are negligible, only torque and acceleration loads need be designed for. It is suggested that some thought be given to rotor torque loads applied at engine mount pads; this may happen in some designs.

Standard locations for accessories and an engine governor mounting pad also are desirable features. An additional power take-off appears to be in order for operating a cooling fan, hoist, additional generators, and wheel drive. Adapting the crankshaft rear-end is said to be a good way of achieving this.

Crankshaft ends should pattern standard SAE propeller shaft end types. Present design trends show it desirable to change crankshaft ends by shortening spline length or by providing flange mountings.

Among the other items recommended are visible timing markings (with fan and ducting installed) and provisions for hand-turning the engine for timing and clearing the bottom cylinder of oil if available accessories cannot do the job.

SAE Helicopter Group Sparks Rotary Craft Improvements

Present at the last meeting of the SAE Helicopter Committee, which recently issued a report on helicopter engine characteristics and one on universal joints, p. 66, were in the usual order: Major J. C. Siltamen, Air Materiel Command; M. C. Gluhareff, Sikorsky aircraft; M. A. Wachs, Sikorsky Aircraft; R. A. Wolf, Bell Aircraft Co.; M. L. Stoner, SAE Staff; Chairman R. H. Prewitt, Prewitt Aircraft Corp.; Com. J. W. Klopp, Bureau of Aeronautics; R. E. Tingley, Piasecki Helicopter Co.; J. R. Huber, Firestone Aircraft Co.; L. L. Douglas, Kellett Aircraft Corp., and Dr. Alexander Klemin. The Committee is working on other projects concerning helicopter performance and components

LOW-COST BORON ELEVATES STEEL PROPERTIES

Tests Show Needling May Save On Alloys

LIGHT has been shed on a new steel-making technique that offers the physicals of high alloys with inexpensive boron, according to a recently-issued report based on over three years of work conducted for Army Ordnance by a subcommittee of the SAE Iron & Steel Technical Committee.

Aimed at determining the merits of "boron-needling" as an alloy conservation measure during the war, tests were made of a 100-ton steel heat needled with seven commercial additives. While limited, these tests point up the possibility of less costly steels – with little or no sacrifice in quality – by substituting boron for more costly alloying elements.

Needled-steel tests led to these conclusions:

1. All seven additives – Silcaz, Grainal 79, Ferroboron, Bortam, Grainal 1, Silvaz, and Borosil – were substantially equally effective in improving the properties of the 0.45 carbon-1.50 manganese steel (called 13T45). After needling, this steel had practically the same hardenability and mechanical properties as SAE 4145, with the exception of the lower notched toughness of the former steel at relatively low hardness.

2. The needled steel proved suitable for an army truck part (torque rod pin end) in both quality of the finished part and fabricated characteristics. WD 4145 normally was specified for the part.

3. In M-1 rifle parts, the 13T45 steel compared with the normally-used WD 8745 in both performance tests and fabricating properties.

The report, soon to be made available through the SAE Special Publications Department, says that the test composition chosen was a straight carbon-manganese steel (0.43-0.48 carbon and 1.35-1.65 manganese) with residual elements, held as low as possible. It was believed that, properly needled, this analysis would have a hardenability close to that of SAE 4145 – tested in parallel with the treated steel.

It also was felt to be the one composition that could effect maximum savings of critical alloys and at the same time be produced at the least cost. Previous work on manganese steels indicated their uniform response to needling. They offered a good base composition for evaluating different kinds of needling agents.

The 100-ton heat, advises the report, was divided into 32 ingots and treated with seven different boron additives. As a control, one of the ingots was not treated. Machinability, chemical and physical properties were tested by one steel company, seven automotive manufacturers, a university, a research institute, and two government agencies.

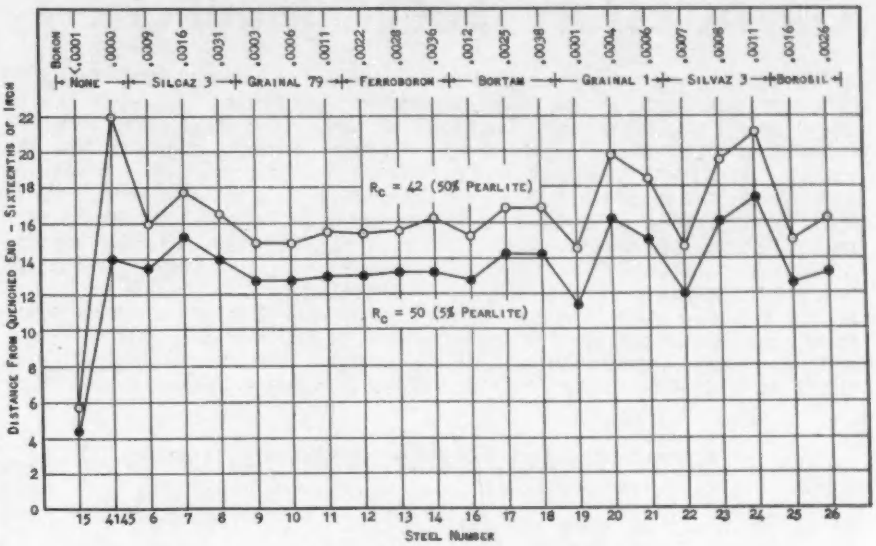


Fig. 1 – Jominy hardenability of the 0.45 carbon-1.50 manganese steel, treated with seven commercial boron additives, compared with SAE 4145 steel

These shop and laboratory tests disclosed the following:

Chemical analysis on top and bottom of all ingots in the special heat showed good uniformity throughout. All ingots were commercially clean, although the inclusion count in boron-treated ingots was higher than that of the untreated ingot.

Grain size seemed to increase with addition of boron. This tendency was partially offset by adding sufficient amounts of grain-refining additives.

When quenched at 1550F, fracture-tested bars all exhibited fine grain size.

Boron Boosts Hardenability

As for physical characteristics, addition of boron in the ingot mold greatly increased the hardenability. Extent of this effect appeared not to depend critically on the amount or composition of the intensifiers.

Average Jominy hardenability at J-50 compared with that of SAE 4145. At J-42, SAE 4145 was somewhat higher in hardenability. Fig. 1 shows the Jominy hardenability of the steel treated with the seven different agents compared with SAE 4145.

Quenched and tempered, boron-treated steels had superior properties than the untreated ingot at 450F to 600F draw temperatures. At draw temperatures below 800F, 13T45 had better tensile properties than SAE 4145, although the opposite was true at higher draw temperatures.

Notched toughness at room temperature, according to the report, varied with boron content and hardness of the hardened or tempered steel.

Machinability Good

Fabricating qualities of the needled steel were generally good. Boron-treated ingots showed better grinding characteristics than the untreated ingot in both the hardened and tempered condition. Forgings of this material were not any different from those of SAE 4145, NE 8645, or NE 9445.

Machinability of needled steel was as good as, if not slightly better than, that of SAE 4145, based on shop experience with a production run of about 40,000 lb of forgings. Fabrication of M-1 rifle parts confirmed this good machinability.

In heat-treating, the 13T45 steel responded to normalizing, annealing, and hardening like the untreated material.

The report itself contains in full detailed data on test procedures and results with a blow-by-blow discussion of program as it progressed. The SAE Special Publications Department will make the report available to members for $1.00 and to non-members for $2.00.

R. B. Schenck, of Buick Division, GMC, was chairman of the Special Addition Agent Steels Subcommittee that prepared the report.

Aeronautic Industry Queried On Accessory Speed Mounts

THE simple clamp-type of attach-detach accessory mounting is favored over three other types by the industry, a recently completed survey reveals. The SAE Accessory Drives and Flanges Committee made the study in developing a proposed Aeronautical Recommended Practice.

While all four types, illustrated below, are being considered for inclusion in the tentative ARP, the questionnaire circulated among aircraft engine and accessory manufacturers was aimed at both determining their acceptance in industry and receiving specific comments.

Chairman N. F. Rooke, Pratt & Whitney Aircraft, reports that the voting on the preference for each of the four quick attach-detach units is as shown in Table 1. Particularly interesting, he says, are the reasons given voting or not voting for each of the devices.

Many said they selected Type 1 because it is the simplest, lightest, and cheapest. But they admitted that Type 2 is faster. Some favored Type 2 because it permits mounting by one man, whereas two men are required to install a heavy accessory, such as a generator, using Type 1. (The latter point met with pros and cons at the last Committee E-24 meeting.)

Disadvantage cited for Type 2 was the possibility of frequent breakage of the spring for keying the accessory in position.

While some judged Type 3 as the fastest, they considered it too complicated. Also it was thought that dirt in the moving assemblies would impede installation.

Those voting for Type 4 felt it is the most positive and secure fastening of the four. One comment pointed out that Type 4 provides the easiest machining of the accessory case.

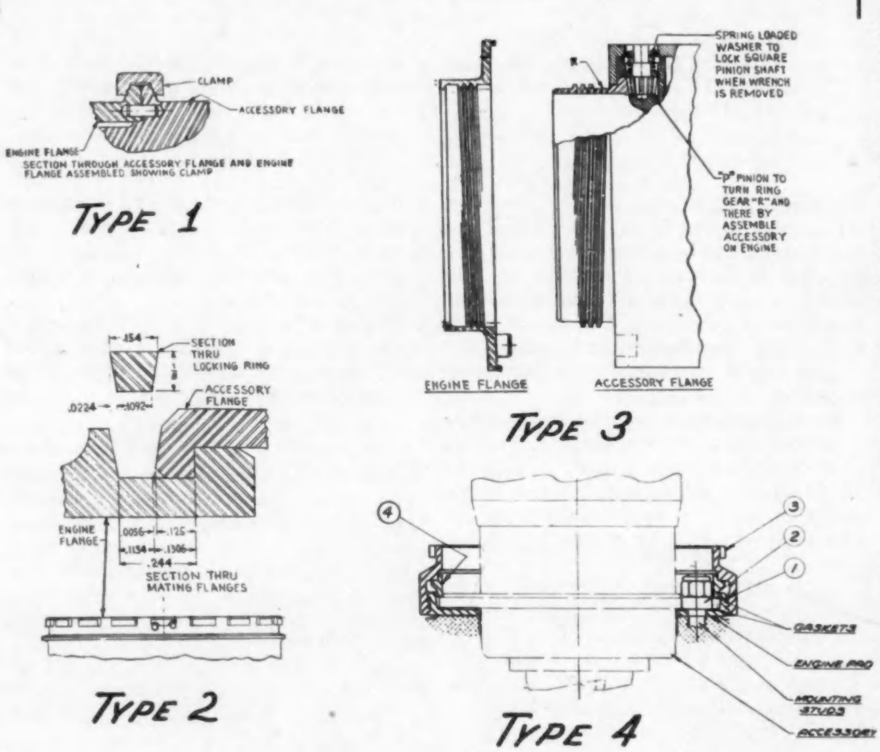
These opinions, advises Chairman Rooke, reflect casual comparisons and examinations and are not the evidence upon which the Committee will make its final determinations. Final selection of the type or types to be recommended will be based on actual service experience and field tests with these devices now under way.

Need for these quick attach-detach mountings stems from the difficulty in removing and installing accessories. They usually are joined to the engine with four to ten bolts, often inaccessible. Time for removing these bolts is excessive. These proposed devices are designed to speed this operation.

Table 1 – Summary of Industry Votes on Four Types of Proposed Accessory Mountings

	First Preference	Second Preference	Third Preference	Fourth Preference
Type 1	16	4	1	2
Type 2	3	9	4	3
Type 3	1	2	5	4
Type 4	4	3	3	4

PROPOSED ACCESSORY SPEED MOUNTS



Type 1, the first of four quick attach-detach accessory devices considered for standardization by SAE Committee E-24, is a clamp-type mounting. Three torque-carrying dowel pins align the engine mount and accessory. A double or triple-hinged clamp, grooved to clasp tightly the chamfered accessory and engine flanges, is held in place by one bolt.

In Type 2, interlocking jaws on both the engine and accessory flanges are held in place by a wedge-shaped locking ring.

An accessory with a Type 3 mounting is assembled on the engine by turning pinion P, which turns ring gear R, joining the externally-threaded accessory flange and the internally threaded engine flange. Six equally spaced pins take the torque reaction.

Type 4 is similar to Type 3. In this case the large nut (3) on the accessory is screwed to the threaded outer diameter of plate (1), secured to the engine pad, by spanner wrench and safety-wired in place.

Ground Work Laid For T&M Formulas

TRANSPORTATION and Maintenance Committee on Classification and Evaluation of Transportation Engineering Formulas has more clearly defined its plan of attacking its assignment.

Chairman F. B. Lautzenhiser, International Harvester Co., revealed that personnel and objectives of the three working subcommittees have been determined. (See p. 69 of the November, 1946 SAE Journal for overall scope of the committee.)

First group, that will consider the formulas themselves, will be chairmanned by M. C. Horine, Mack Mfg. Co. It will swing into action when the other two subcommittees have gathered all the preliminary data.

Second group, under Carl Saal, of

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News..
..OF THE SOCIETY

Administrative "Guides" For Sections Approved

Specific "guideposts" to aid SAE Sections and Groups in administration of their financial operations have lately been approved by Council and circulated to Section officers throughout the country. Strengthening SAE's traditional belief that Sections should have the greatest possible autonomy in financial matters, the "guideposts" stress necessary relationships with Society policies and touch on practical phases of Section administration.

Section and Group governing boards are urged to take full responsibility for administering their funds for normal operations, but are asked to obtain Council approval before (a) taking any action which would impose obligations on a future Governing Board, or (b) make capital expenditures for purchase of equipment such as projection machines, and so forth.

Routine Procedures

Listed as "normal operations" are: Governing Board and committee meetings; maintenance of mailing lists and records, printing and mailing of announcements, meeting room rental, public address system rental, speakers' expenses, losses on dinner meetings, registration assistance, student awards, supplies, telephone, telegraph, entertainment, and so forth. (All of these expenses are not common to all Sections, but are typical of those administered by Governing Boards.)

Section publications are heartily approved as a means of bringing to members announcements of local meetings, messages from offices, news of members, reports of local meetings, and of local participation in SAE National Meetings. It is urged that Section publications be limited to these areas, however, and that advertising solicitation be kept on a "value-received" basis as in the case of the SAE Journal and other publications of the national Society. Broadly, it is urged, Section publication advertising should be so sold as to assist, not impede, sales of advertising in SAE Journal upon the income of which much Society service to the individual member is predicated.

A long-standing bar to holding of revenue-producing exhibits by Sections and Groups is reaffirmed in the "guideposts," while conduct of monthly meetings on a break-even basis is urged. Small additional amounts over and above meal costs and guest fees to nonmembers, are suggested as means to the latter end.

Renewed emphasis is placed upon filing of Section and Group budgets and monthly financial reports to facilitate distribution of the funds which go from the Society to Sections on a per member basis. Sections and Groups are urged to inform Council before debts are incurred which might bring an operating deficit – when Council may, at its discretion, appropriate sufficient funds to offset such expenses.

Additional Funds

In making appeals for industry support of non-technical entertainment activities, the "guideposts" urge Sections "not to exert pressure or conduct their solicitations in any way which might injure goodwill toward the Section or the Society."

Recognizing that a number of Sections complete their fiscal years with a credit balance in their dues accounts, Council points out that such funds are transferred to SAE's general treasury and urges against accumulation by Sections of large bank accounts as reserves. Monies transferred to the Society's treasury at the close of the fiscal year, the "guidepost" reads, are used for the benefit of all the members and are available to assist those Sections or Groups which may need financial aid.

The "guideposts" were prepared for Council by a special committee chairmaned by R. F. Steeneck, 1946 Sections Committee chairman; R. J. Waterbury, 1947 Sections Committee chairman; A. T. Colwell, Finance Committee chairman; B. B. Bachman, SAE treasurer; and W. S. James, Publication Committee chairman.

Complete copies of the "guideposts" have been in the hands of all Section and Group chairmen and treasurers since early in March.

New Student Pin Approved

GOLD on a green enamel background, the new SAE Student Membership pin was recommended by the Student Committee to Council.

The price to students will be 50¢ each, including tax, instead of $1.20, the cost to student members of the present pin.

Student Enrollment Increases

ALMOST doubling last year's totals, 1399 SAE Enrolled Students were recorded as of February, as compared with 764 a year ago.

Of these, 1262 are students in 64 colleges and universities in the United States and Canada, 31 are in the mili-

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About

P. L. BARTER, vice-president of McCord Corp., Detroit, for the past 23 years, has been elected to the newly-created office of vice-chairman of the board of directors. He will continue to hold his present post as vice-president of the corporation.

LESTER J. HENDERSON, who had been assistant general sales manager at the Weatherhead Co., Cleveland, was recently appointed general sales manager of the Aeroquip Corp., Jackson, Mich. Well-known throughout the aviation industry, Henderson has been an active member of the SAE. He has been chairman of Committee A-3 Aircraft Valves, Fittings and Flexible Hose Assemblies and is a member of the Aircraft Activities Membership Committee for 1947.

PAUL W. SEILER, well-known Detroit automotive figure, president of Motor Tool Mfg. Co. and formerly president and general manager of Ternstedt Mfg. Co., Yellow Truck & Coach Mfg. Co., and General Motors Truck Corp., has recently been elected to the board of directors of the Standard Products Co., Detroit.

RUSSELL H. McCARROLL is a nominee for a three-year term as director of the American Foundrymen's Association. He is director of chemical and metallurgical engineering and research at Ford and a member of SAE Technical Board.

ROBERT C. WALLACE, formerly vice-president in charge of engineering at Marmon-Herrington Co., Inc., has resigned to become executive engineer of the Diamond T Motor Car Co., Chicago truck manufacturer. Wallace is chairman of the Indiana Section and was its treasurer from 1935 to 1944.

ACF-Brill Motors Co. announces the resignation of **HOWARD A. FLOGAUS,** who had been vice-president in charge of engineering. Flogaus has been an active member of the SAE and was vice-president representing Bus & Truck Engineering for 1945. Announcement is also made of the appointment of **WILLIAM E. WILLIAMS** as development engineer. Williams has been associated in the field of automotive engineering for the past 26 years, having spent 19 years with General Motors Truck and Coach Division. Just prior to joining ACF-Brill, Williams was chief engineer of the Fitzjohn Coach Co. in Muskegon, Mich. **FRANK A. KATELEY** continues as chief engineer.

The appointment of **WARREN D. FOLTZ** as New York manager of Bendix-Westinghouse Automotive Air Brake Co. was announced recently. He will make his headquarters in the regional office of Bendix-Westinghouse located in the Empire State Building.

JOSEPH GESCHELIN, Detroit Editor of Chilton Publications and vice-chairman of the SAE National Production Activity Committee, addressed the Factory Managers' Group of Borg-Warner Corp. in Chicago on March 19. Subject of the talk was a summary of current developments in materials handling and production equipment leading to decreased prime costs in the face of rising labor and materials costs.

Now serving as district manager of the household sales department, Permutit Co., New York City, **ARCHIBALD T. MILLER** was sales engineer, Eclipse-Pioneer Division, Bendix Aviation Corp., Teterboro, N. J.

After having served as a captain in the Indian Army, **PETER R. HAMILTON ASH** is now associated with the Bombay Galvanizing Co., Ltd., Bombay, India.

R. W. ST. AUBIN, who had been maintenance foreman, American Overseas Airlines, Inc., Shannon Airport, County Clare, Eire, has been transferred to La Guardia Airport in New York City.

Until recently foreman of the Cleveland Diesel Engineering Division, General Motors Corp., **STEVE A. SCHNEIDER** is now district foreman at Creole Petroleum Corp., Maracaibo, La Salina, Venezuela.

Before joining Federal-Mogul Corp., **THOMAS R. BLAKESLEE** was sales engineer, Warren Refining & Chemical Co., Cleveland. At his new position, Blakeslee will be temporarily located in Detroit, and later in Chicago, working in a sales engineering capacity, contacting engine and equipment builders in Illinois, Iowa, Wisconsin, Minnesota and Missouri.

Formerly a captain in the U. S. Army Air Forces at Wright Field, Dayton, **JAMES D. HOFFMAN** has been appointed powerplant development engineer with North American Aviation, Inc., at Los Angeles Municipal Airport.

CHRIS BUTTERWORTH, preceding his appointment as plant engineer at U. S. Gypsum Co., Plaster City, Calif., was the managing editor of Chek-Chart Corp., Chicago.

HOLLEY B. DICKINSON has resigned his position as flight test supervisor in charge of flight tests of the Constellation at Lockheed Aircraft Corp., Burbank, Calif. He recently toured South America, Mexico and Guatemala.

Members

DAVID WARK, an engineer connected with American Airlines, Inc., Maintenance Depot, Tulsa, Okla., was formerly located in New York City.

PAUL R. GUERIN is now owner and manager of Guerin-Zimmerman Co., Cleveland, previously called the A. E. Zimmerman Co. **A. E. ZIMMERMAN**, the former owner, recently retired, but his son **MERRITT A. ZIMMERMAN** will continue to be associated with the company, designing the tools and dies required for the manufacture of industrial sheet metal products. Mr. Guerin was formerly chief engineer at Johnston & Jennings Co., Cleveland.

Having resigned from Aerojet Engineering Corp., Azusa, Calif., **ALAN H. BLAIR** is now a major in the U. S. Army Air Forces, stationed at Andrews Field, Md.

J. R. McLEAN, until recently connected with Exide Batteries of Canada, Ltd., Toronto, has been named general manager, United Auto Parts, Ltd., Ontario Division, also in Toronto.

Preceding his appointment as president and treasurer of Commercial Aircraft, Inc., Jackson, Mich., **ROBERT L. NULTY** was sales manager, Walker Mfg. Co. of Wis., same city.

R. R. HUTCHINSON has been promoted to assistant chief engineer of Pontiac Motor Division in charge of current engineering and new projects. He received his engineering education at Purdue University and was appointed motor engineer for the first Pontiac produced.

After having been in the U. S. Navy, **KARL A. MERTZ** is staff assistant to the president at G. M. Giannini & Co., Inc., Pasadena, Calif.

G. W. THOMAS of Continental Motors Corp., Muskegon, Mich., was recently elected to the executive committee at the annual meeting of the Internal Combustion Engine Institute.

Prior to taking his present job as technical representative for the Puritan Co., Rochester, N. Y., **B. A. BANNON, JR.**, was superintendent of operations and maintenance, Eves Trucking Co., Pittsburgh, Pa.

H. W. JACKSON, formerly assistant service manager, has been named service manager of the Bendix-Westinghouse Automotive Air Brake Co., with headquarters at Elyria, Ohio. Mr. Jackson replaces **D. H. ROBINSON**, who has been transferred to the company's manufacturing division where he will be in charge of several important phases of production.

FRED C. PURKEYPILE, owner of Corvallis Auto Parts Co., Corvallis, Ore., has sold interest in his business and plans to take an extended vacation.

Now connected with the U. S. Patent Office, Washington, D. C., as patent examiner, **RICHARD B. WILKINSON** was in the U. S. Army, Fort Monmouth Signal Laboratory at Red Bank, N. J.

Chrysler Corp. engineers are working with the U. S. Army in connection with special sub-zero studies this winter in Alaska, in the Aleutians, and in Northern Wisconsin, it was revealed recently by **J. C. ZEDER**, chairman of the company's Engineering Board. SAE Member **PHIL KENT**, chief electrical engineer of the company, worked with Task Force "Frigid" in Alaska, where the constant temperature was between 70 and 80 degrees below zero. Test trips, such as this, are made by engineers and test drivers in all extremes of weather and climate, to make cars and trucks of the future safer, more comfortable and more efficient.

The Standard Oil Co. of New Jersey announces the promotion of **HARRY L. BAKER** as its engineering representative in Detroit. He will replace **GEORGE H. SCHOENBAUM**, who has been promoted to foreign technical representative of Foreign Marketing Coordination, with headquarters in London. Baker is at present in London with the Esso European Labora-

W-O ENGINEERING STAFF CHANGES

Huber

Cuma

DeSmet

Calkins

Talley

Addition and reassignment of personnel of the engineering department at Willys-Overland Motors, Inc., was announced recently by **DELMAR G. ROOS**, director of engineering. SAE Members involved are **PAUL HUBER**, formerly assistant director of the General Motors Proving Grounds at Milford, Mich., as director of research, **CHARLES CUMA**, engine development, **E. C. DESMET** is assistant to the vice-president in charge of engineering and **L. E. CALKINS** is chief chemist. **JOE H. TALLEY** has been advanced to general manager of the aircraft and research division.

Other changes in the engineering department include **RUBERT E. BUSEY**, who will be in charge of truck engineering, **WALTER F. BENNING** as technical assistant to Roos and also in charge of passenger car engineering, **F. L. MILLS**, chief draftsman of the chassis division and **D. D. STONE** has been appointed research engineer.

JOHN A. BRITTON, JR. has been named vice-president of the Enjay Co., Inc., new name for Stanco Distributors, Inc., New York City. He had been sales manager before the change in name. Other SAE Members at Enjay are E. N. CUNNINGHAM, I. E. LIGHTBOWN, H. B. HEFFELFINGER, A.E. LEE and A. BRUCE BOEHM (below).

A. BRUCE BOEHM of the Enjay Co. Inc. has been promoted to sales manager, taking Mr. Britton's place. He had been assistant manager of the Paramins Division, before the change in company name.

WALTER H. NILES is now president of the Machine Steel Products Corp. in New York City. This firm does consulting engineering and are also contractors in packaging. During the war Niles was in the U. S. Army Air Forces. He developed a turbo-supercharger regulator testing kit for B-29's, which would test the turbo-supercharger regulator on the ground, but under conditions prevailing at 30,000-ft altitudes.

JOSEPH M. GWINN, JR., who had been a division manager with Consolidated Vultee Aircraft Corp., Nashville, Tenn., is now chief engineer, Hoist and Body Division, Gar Wood Industries, Wayne, Mich. Eventually he plans to do consulting work in aeronautical engineering.

tories and will not take over his promotion in Detroit until about the first of June.

ROBERT C. KELLOGG is an engineer at Skidmore-Wilhelm Mfg. Co., Cleveland, Ohio. He had been production engineer at Perfection Stove Co., Inc., also in Cleveland.

At a director's meeting in January, **PAUL C. ROCHE** was elected president of the Northwestern Pennsylvania Section, Society of Plastics Engineers, Inc., having been secretary of that group for the year 1946. Mr. Roche is sales engineer of NOSCO Plastics, Erie, Pa.

S. J. STEVEN has relinquished his position at Republic Aviation Corp., Farmingdale, L. I., N. Y., to become assistant chief mechanical engineer at Pioneer Gen-E-Motor Corp., Chicago.

After relinquishing his position at West Coast Lubri Gas Co., Los Angeles, **EVERETT S. ALLEN** is now owner of Red Allen, Clearwater, Calif.

R. W. HAUTZENROEDER resigned his position with the tractor division of the Fate Root Heath Co., Plymouth, Ohio, to become project engineer of tractors with Harry Ferguson, Inc.

Preceding his appointment in the service development division, General Motors of Can., Oshawa, Ontario, **NORMAN C. MILLMAN** was director of vehicle development, MGO, Britain, Department of National Defense, Ottawa, Ontario.

Prior to taking his present job as design engineer, International Harvester Co., Chicago, **EVERETT M. SANDAHL** was employed with Torrington Co., Bearings Division, in the same city.

Until recently associated with White Motor Co., Cleveland, **WILLIAM D. WATKINS** has been appointed treasurer and director of purchases at Torcon Corp., Chagrin Falls, Ohio.

LESTER E. WETZLER was recently appointed assistant chief engineer at James Cunningham Son & Co., Rochester, N. Y.

RICHARD W. MUCHMORE, prior to his appointment as superintendent of Dura-Bond Bearing Co., Palo Alto, Calif., was plant engineer at Federal Mogul Corp., San Francisco. He is an active member of the Northern California Section and was its secretary during 1945-46 and its treasurer during the 1946-47 term.

Formerly a design engineer with Bendix Aviation Corp., Detroit, **WILLIAM H. HORN** is now an engineer with United States Rubber Co., also Detroit.

GEORGE F. HUGHES, supervisor of maintenance with Union Pacific Stages, has been transferred from Spokane, Wash., to Omaha, Nebr.

MICHAEL W. LARINOFF has entered M.I.T. as a graduate student. Previously he had been affiliated with Ebasco Services, Inc., N. Y.

HERBERT G. McCLEAN who had been manager of the tractor division, Crompton Parkinson, Ltd., Chelmsford, Essex, England, is now with the electromotive division of General Motors Corp., La Grange, Ill.

Prior to becoming vice-president and purchasing agent at Co-Operative Industries, Chester, N. J., **CARL E. LANE** was purchasing agent, Titeflex, Inc., Newark.

Announcement has been made of a change in name from Rosco Laboratories, Inc., to Royston Laboratories, Inc., located in Blawnox, Pa. **W. A. ROYSTON, III,** is a member of the board of directors.

JAMES L. MYERS, executive vice-president of the Cleveland Graphite Bronze Co., has been elected secretary-treasurer of the Automotive & Aviation Parts Manufacturers, Inc., for the 1947 term. **FREDERICK C. CRAWFORD,** president of Thompson Products, Inc., retiring president, is now a director retaining office for an unexpired term.

H. R. NOGUEIRE, formerly service manager, General Motors Overseas Operations, N. Y., has become general service manager, General Motors Do Brazil in Sao Paulo.

Now affiliated with the Air Materiel Command Headquarters at Wright Field, Dayton, Ohio, **LANGDON F. AYRES** was a student at Purdue University.

CHESTER A. CLARK, now a mechanical engineer with the Naval Research Laboratory, Washington, D. C., was formerly in the U. S. Army.

Recently stationed at Camp Lee, Va., with the U. S. Army, **WILLIAM W. KOENIG** is now at the White Sands Proving Grounds, Las Cruces, N. Mex.

WILLIAM SWALLOW, formerly associated with R & B Short Bros., Ltd., Rochester, Kent, England, as chief production engineer, is now in New York City with General Motors Overseas Operations.

After relinquishing his position as technical production engineer with Ford Motor Co., Ltd., Eccles, Lancs., England, **A. W. VICKERS** is now serving as managing director of Vickers-Goodwin, Ltd., and as a director of Sutton Motors (Stoke on Trent) Ltd. Both firms are located in Kidsgrove, Staffordshire.

JAMES T. HARKER, previously operations engineer at American Overseas Airlines, Inc., La Guardia Airport, N. Y., was recently appointed senior aerodynamicist, Boeing Aircraft Co., Seattle, Wash.

C. R. GATES, eastern sales manager for Farrell Mfg. Co., formerly of Long Island City, N. Y., now has offices in Philadelphia and Joliet, Ill.

A. E. MOREILLAN has resigned his position as chief engineer of Hymatic Engineering Co., Ltd., Redditch, Worcestershire, England. He plans to go to Switzerland to establish himself as designer-inventor and also as a consulting engineer in the field of pneumatic equipment applied to the automotive industry.

Before joining Boeing Aircraft Co., Seattle, Wash., as an engineer, **WILLIAM ST. GERMAIN** was a laboratory engineer connected with Aircooled Motors, Inc., Syracuse, N. Y.

Recently appointed general manager at Polytechnics Associated, Jersey City, **CHARLES F. LOEW** was formery project engineer, York Research Corp., New York City.

E. LASS has been appointed senior mechanical engineer at Cornell Aeronautical Laboratory, Buffalo, N. Y.

HOWARD A. TUBBS owner of Tubbs-Craft, Whitewater, Wis., is doing private experimental work. Before owning his own business, he was chief engineer at Whitewater Mfg. Co.

DUNCAN C. CROOKS is vocational instructor and superintendent of transportation at the new Mount San Antonio College, in Pomona, Calif. Prior to taking his present job, Crooks was vocational instructor at Bonita Union High School, La Verne, Calif.

Before becoming vice-president of Stroh Industries, Detroit, **W. H. PEET** was partner and chief engineer at Die Industries, also in Detroit.

Until recently chief engineer at Douglas Engineering Co., Lincoln Park, N. J., **EDWARD B. DOUGLAS** has now been advanced to president.

Weatherhead Engineering Changes

JOHN BALDWIN has been appointed assistant chief engineer with direct supervision of the Project Engineering and Drafting and Design Groups, at the Weatherhead Co. in Cleveland. He was formerly automotive project engineer at Weatherhead.

B. R. TEREE has been appointed laboratory director at Weatherhead Co. In his new position Teree, who had been project engineer in charge of aircraft development, will have supervision over the Weatherhead engineering laboratories.

CLARENCE L. GILLHAM recently became merchandising manager of Hudson Florida Motors, Inc., Jacksonville, Fla. Prior to this he was southeastern technical representative of Willys-Overland Motors, Inc., Toledo, Ohio.

Dardelet Threadlock Corp., Detroit, recently changed its corporation name to Lock Thread Corp. **EDWIN B. JACKSON** is president of the firm.

According to **CHARLES A. WINSLOW,** president of Winslow Engineering Co., Oakland, Calif., SAE Members who have been promoted at Winslow are **L. L. MOORE,** vice-president and general manager, and **W. G. NOSTRAND,** executive engineer. Moore had been factory superintendent and Nostrand had been chief engineer.

WOLFGANG E. MEYER recently accepted a position at North Carolina State College, Raleigh, N. C.

Now in the employ of Servel, Inc., Evansville, Ind., as a service representative, **PAUL E. CHAMBERLIN** had been project officer in the U. S. Army Air Forces at Wright Field.

Now owner and general manager of the Triangle Equipment Co., San Diego, **ROBERT E. RADCLIFFE** was previously chief engineer.

WILLARD E. CROTTY has become president of Crotty Corp., Jonesville, Mich. Formerly he had been general manager and co-partner of Auto Products Co., Jonesville.

ROY D. SMITH resigned recently as

JOHN W. OEHRLI, who had recently been an engineer with McCulloch Aviation, is now consulting engineer with the Salisbury Motors, Inc., subsidiary of Northrop Aircraft, Inc., Pomona, Calif. His present work includes development of small engines for automotive and industrial service.

WARREN S. LOCKWOOD is now owner of Warren S. Lockwood, Washington, D. C., foreign trade consultants. They also publish "Lockwood's Monthly Rubber Report." Before owning his own business, Lockwood was executive vice-president of the Rubber Manufacturers Association, Inc., in New York City.

chief engineer of Bee Line Co., Davenport, Iowa, to establish Smith Engineering & Machine Co., Pueblo, Colo., and to become its president and manager.

Associated previously with the U. S. Bureau of Surplus Property, Seattle, Wash., **WILLIAM J. MILLER** has been appointed president and general manager of the Washington Truckstell Sales Inc., Seattle.

NILE E. FAUST, has relinquished his position with the Elliott S. Peterson Co., Portland, Maine, and is now owner of the Nile E. Faust Motor Co. in Concord, N. H. He is the authorized dealer for Studebaker Corp. in that area and is interested in the sales and service of new and used Studebaker cars and trucks, but will also service other makes.

ELBERT L. POTTER, director of sales and service at Houdaille-Hershey Corp., Buffalo, was general sales manager at French & Hecht Division, Kelsey-Hayes Wheel Co., Davenport, Iowa.

Having resigned his position as assistant professor of automobile engineering at the Case School of Applied Science, Cleveland, **ARTHUR P. FRASS** is now living in Rio de Janeiro, Brazil.

Prior to becoming an aeronautical engineer with the Civil Aeronautics Administration in Kansas City, Mo., **HAROLD FRANCIS TWYMAN** was superintendent of power plants, Trans World Airline, same city.

Preceding his appointment as engineer, Thompson Aircraft Products, Cleveland, **ROBERT CLIBORN** was affiliated with Chevrolet Motor Division, General Motors Corp., Buffalo, N. Y.

E. F. RIESING, chief automotive engineer at Firestone Industrial Products Co., recently gave a talk, "Rubber and Automotive Production," before the Engineering Training Group at Ford Motor Co. He demonstrated the Joule effect with the Weigan pendulum. Earlier in December, he also presented an annual review of the technical advances in rubber before the Rubber and Plastics Division of ASME.

MARVIN L. SMITH, who graduated recently from Michigan State College, East Lansing, has joined Detroit Steel Products Co., as a draftsman.

Until recently connected with Great American Industries, Inc., New York City, **HENRY D. EISENGREIN** has been appointed district manager of Diamond T Motor Car Co., same city.

Glenn L. Martin Co., Baltimore, announced recently that it is moving into the helicopter field with the purchase of the assets and patents of Rotawings, Inc., of Philadelphia. **GLENN L. MARTIN,** president, said that there is no plan for developing a complete helicopter at present, but that work will be carried on with vital parts of rotating wing aircraft.

Transferring from the General Chemical Co., Marcus Hook, Pa., **CHARLES L. BEST** is now connected with the mathematics department of Mohawk College, Utica, N. Y.

Prior to taking his present job as superintendent of maintenance at Carrib-Bee Aero Service & Supply, Miami, **ABNER L. MINS, JR.,** was sales representative for AC Spark Plug Division, General Motors Corp., Atlanta, Ga.

HARRIS C. HUG has been advanced from lead engineer to design engineer of research at Boeing Aircraft Co., Seattle.

HAROLD N. MYERS has resigned his position as research engineer with Sealed Power Corp., Muskegon, after having been connected with this company for over 9 years.

Formerly fleet sales representative for the Ford Motor Co.'s Edgewater District, **ROY HALL** was recently appointed truck and fleet sales manager for this district. He will supervise all Ford sales activities in New York, New Jersey, and Connecticut.

Project Engineer **GEORGE E. ROWBOTHAM,** Fisher Body-Ternstedt Division, GMC Detroit Plant, was recently informed of his appointment as chairman of the General Motors Drafting Practice Committee.

Now in the employ of Gar Wood Industries, Inc., at the Wayne, Mich., plant as designer and senior layout man in the Winch and Crane Division, **JOHN H. ALLMAND** was associated with Graham-Paige Motors Corp., Willow Run, Mich.

Formerly in the U. S. Army at Fort F. E. Warren, Cheyenne, Wyo., **JAMES H. DAVIDSON** has taken a position with the Timken Detroit Axle Co., Detroit.

After graduating from Purdue University early this year, **GLENN J. ALABACK** has taken a position as engineer with International Business Machines Corp., Endicott, N. Y.

HENRY E. BRINK is now a student at the University of California, Berkeley. He had been layout draftsman with the Solar Aircraft Co., San Diego.

Until recently branch manager, H-O Motor Supply Co., Cut Bank, Mont., **WILLIAM M. STOVER** has been appointed a representative at Wilkening Mfg. Co., Philadelphia, Pa., with offices in Salt Lake City.

JAN SOETEN has been appointed managing director of N. V. Autra in Holland. This company is the European representative of the Twin Coach Co., Kent, Ohio. Before his appointment he was affiliated with Van Doorne's Aanhangwagen, Fabriek Eindhoven, Holland.

JOHN V. BASSETT is now chief engineer of Heavy Duty Friction Materials for Raybestos-Manhattan, Inc. At present his headquarters will be in Passaic, N. J. Bassett has been promoted from senior automotive engineer. Some of his new duties will include contacting customers, responsibility for recommending and specifying the types of heavy-duty brake lining and clutch facing to be furnished in the original equipment field, and securing data as to the types of material which are being used on various trucks, buses and trailers.

RICHARD CRETER has been appointed general service manager of the Cummins Diesel Railroad Equipment Co., New York City, following his resignation, in that capacity, from R. B. Rogers Companies, Inc. Vice-chairman for Diesel Engineering of the Metropolitan Section, he had been active on several technical committees of the Society.

HOWARD C. BOZEMAN recently joined the Ray-Brooks Machinery Co., Montgomery, Ala., as manager of sales. His last position was with the International Harvester Co., Industrial Power Division, as a zone manager, covering the states of Alabama, Mississippi, and Louisiana with headquarters in New Orleans.

JERRY M. GRUITCH has been named vice-president of engineering at the O. A. Sutton Corp., Wichita, Kans. He had been assistant chief engineer at the Dodge Division of Chrysler Corp. in Detroit. During the war he was in the U. S. Army Air Forces as a staff ordnance officer in Okinawa.

Upon his graduation from Purdue University, West Lafayette, Ind., **WILLIAM J. TROYER** was appointed engineer in the experimental department at Switzer Cummins Co., Indianapolis.

After resigning his position as chief engineer at Alan Muntz & Co., London, **HAROLD O. FARMER** is now on the engineering headquarters staff of Messrs. Courtaulds, Ltd., Coventry, England.

After relinquishing his position as chief tool engineer at Multi Products Tool Co., Inc., Newark, **ROBERT U. WHITNEY, JR.**, has taken a similar position at Rowe Mfg. Co., Whippany, N. J.

DALE SILAS GRONSDAHL is now enrolled in a graduate training program at the Caterpillar Tractor Co., Peoria, Ill.

Formation of the Frazer Farm Equipment Corp. as a wholly-owned subsidiary of Graham-Paige Motors Corp., was announced recently by **JOSEPH W. FRAZER**, president of Graham-Paige and Kaiser-Frazer Corp.

JAMES E. WASEM, JR., recently became associated with the University of Delaware, Newark, Del., as instructor in their department of mechanical engineering. He had been test engineer, General Electric Co., Lynn, Mass.

ROBERT W. McNABB has transferred from Era Tool & Engineering Co., Chicago, to the Collins Radio Co., Cedar Rapids, Iowa, where he will serve as tool designer.

Prior to becoming technical assistant to the president at Tucker Corp., Chicago, **K. E. LYMAN** was owner of the Research Service located in the same city.

Before joining the Hey Machinery Co., Baldwin City, Kans., **LESTER HEY** was assistant project engineer for Wright Aeronautical Corp., Wood-Ridge, N. J.

Having been appointed sales manager of the W. H. Kildow Co., Tiffin, Ohio, **WILLIAM H. KILDOW, JR.**, was district manager of Shell Chemical Corp. in Chicago.

FRED GRATZ is now owner of Gratz Jewelry Research in Beverly Hills, Calif. He had been associated with George G. Shark in New York City.

PAUL T. HOLLIDAY is an engineer with Douglas Aircraft Co., El Segundo, Calif. He graduated recently from Purdue Universtiy.

After serving in the U. S. Army, **UMBERT G. BALDASSARRI** has been appointed an aeronautical experimental designer with Grumman Aircraft Engineering Corp., Bethpage, L. I., N. Y.

JEROME A. CHURCH has been appointed vice-president of the Aircraft Magneto & Carburetor Service, Inc., Windsor Locks, Conn. Before his appointment, he was project engineer, Bendix Aviation Corp., South Bend, Ind.

Members of the firm of Drew & Peters, aviation consultants, have announced a change in firm name to Drew, Peters, Passen & McDonald. They have offices in St. Louis and Buffalo, N. Y. **JOHN L. DREW** is one of the firm members.

Acting in his capacity as commissioner of aviation, Palm Beach, Fla., **GROVER LOENING**, aeronautical consultant for the NACA, headed a survey team to study reducing noise caused by aircraft flying over that community. He recommended to the CAA that a noise level not greater than 70 decibels at 500 ft should be set as the limit. More than half of the total planes flying over Palm Beach, he reported, were civilian craft and most of these were private planes.

C. L. CUMMINS, president and **H. L. KNUDSEN**, vice-president in charge of engineering at Cummins Engine Co., Inc., Columbus, Ind., were recently awarded gold pins in recognition of 25 years of faithful service to the company.

Connected previously with Allison Division of General Motors as west coast supervisor, Customer Engineering Service, **D. P. FRANKEL** recently joined the powerplant engineering section of Douglas Aircraft Co., Inc., Santa Monica, Calif.

LOUIS POLK is chairman of the board of directors of the Sheffield Corp. of Australia Pty., Ltd. This is a new company formed by the executives of the Sheffield Corp., Dayton, Ohio, to produce and sell Sheffield gages, precision measuring instruments, machine tools and contract engineering and manufacturing services.

MAXWELL B. JESTER has been promoted to manager of the southern division of Calumet Refining Co., Shreveport, La. Previously he had been manager of technical sales in Chicago.

A. P. FONTAINE has relinquished his position as director of aircraft development, Bendix Aviation Corp., Detroit, to become director of the Aeronautical Research Center at the University of Michigan, Ypsilanti.

GEORGE N. SIEGER, president of S-M-S Corp., Detroit, was elected president of the Resistance Welder Manufacturers Association at their 1947 Annual Meeting at the Book-Cadillac Hotel.

ARCH T. COLWELL, SAE past-president and Finance Committee chairman, spoke at the 77th Anniversary Annual Stevens Institute of Technology Dinner, March 7, at the Astor Hotel, New York

OBITUARIES

WALTER TURNER FISHLEIGH

Walter Turner Fishleigh (M '13) passed away in Detroit on Feb. 23.

A consulting engineer for some years prior to his death, Fishleigh pioneered numerous projects in SAE and served the Society actively as a Body vice-president in 1945, as councilor in 1933 and 1934, as chairman of the Detroit Section and in many technical and administrative committee operations. He played a dynamic and important part in development and adoption in 1929 of revisions in the SAE Constitution which established the present setup of Professional Activities – and his initiative was largely responsible for inclusion of a Body Activity as one of the group.

Once a professor at University of Michigan, Fishleigh's high powers of exposition and persuasion were constructively applied to hundreds of SAE projects and programs throughout the years of his membership.

His first connection with the automotive industry was as an executive engineer at Packard. He later returned to the University of Michigan, his alma mater, as professor of engineering, where he organized and directed the first complete course in automobile engineering.

He continued his career while serving as a lieutenant colonel during World War I in the Motor Transport Corps in charge of design and production of motor ambulances. For over 10 years following the war until he began his present practice, Fishleigh was executive engineer with Ford Motor Co.

HENRY E. ROMBERG

Henry E. Romberg passed away on February 22.

At the time of his death, he was assistant chief engineer for Hayes Mfg. Corp., Grand Rapids, Mich. Previously he had been working for the Government as an ordnance engineer at the Massey-Harris Plant, Racine, Wis.

Romberg has also been connected with the Diamond-T Motor Car Co., Chicago, and the Nash-Kelvinator Corp. in Milwaukee.

CHARLES G. MORGAN, JR.

Charles G. Morgan, Jr., manager of the department of operations, American Trucking Associations, and one of the oldest employees in point of service at its headquarters, died Feb. 3 at the age of 53.

He had been associated with ATA since 1933 and previously had been with American Highway Freight Association, one of two organizations merged to form ATA.

For many years he had been active in the highway safety field, serving on various committees of national safety organizations. A few years ago Morgan was one of the sponsors of the short course for truck fleet supervisors at Pennsylvania State College and assisted in the expansion of the national program.

He also directed development of the National Truck Driving Roadeo, annual competition to select the nation's safest and most capable drivers.

JOSEPH A. DONNELLY

Joseph A. Donnelly, vice-president of the Autocar Sales & Service Co., died in Chicago on March 9.

"Joe" Donnelly's experience in the motor truck industry went back to the early days when it was necessary to convince a prospect that it might possibly be to his advantage to displace a horse or two and try a motor vehicle.

From 1919 to 1922 he was the Minneapolis branch manager for Mack, and from 1922 to 1930 he was the Mack manager in Chicago. He joined the Autocar Organization in 1930 as Chicago branch manager, and six years later he was elected to the position he held at the time of his death.

RICHARD EDSON MARSTON

Richard Edson Marston, a member of the SAE since 1922, passed away on Dec. 30, 1946

After his graduation from college, he moved from his native city of Baltimore to Indianapolis, where he first came in touch with the automotive industry through Howard Marmon, who was then developing the famous Marmon automobile.

Leaving Indianapolis, Marston became connected with the Packard Motor Car Co. in Detroit, where he remained until 1918. In that year he became assistant engineer for the Sheldon Truck Co. of Rochester, N. Y., and in 1920 he was appointed chief engineer.

From 1931 until the time of his death, Marston was associated with the Autocar Co. of Ardmore, Pa., in their Engineering Department.

He was always interested in the activities of the SAE and regular in attendance at Section meetings.

DR. J. HARRY CLO

J. Harry Clo, PhD., director of research at A. Schrader's Son, Division of Scovill Mfg. Co., Inc., Brooklyn, N. Y., died Feb. 22 in Waynesville, N. C., at the age of 65. He had been a member of the SAE since 1926.

Following a teaching career as professor of physics, he came to Brooklyn in 1924 and organized the research laboratory of A. Schrader's Son.

During the war, Clo was instrumental in the development of oxygen valves and equipment used in life belts, life rafts and in diving apparatus used by our armed forces. He also did development and research work on air controlled devices used in airplanes and automotive equipment.

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City. Thompson Products vice-president in charge of engineering spoke on "The Future of Engineering." **HERMANN K. INTEMANN,** assistant general sales manager of Thermoplastics Department, Bakelite Corp., and the Institute's Alumni Association's president, presided.

JOHN F. SLOAN is now employed as an engineer with the Stork Engineering Co., Saginaw, Mich. Formerly he had been development engineer with the Saginaw Products Corp.

Recently graduated from Purdue University is **JAMES S. DAVIES,** who is now a draftsman with the Commonwealth & Southern Corp., Birmingham, Ala.

DONALD P. FRANKEL is now in the employ of Douglas Aircraft Co., Inc., Santa Monica, Calif., as a powerplant engineer. Prior to this he was west coast supervisor, Customer Engineering Service, Allison Division, General Motors Corp., Los Angeles.

Now a consultant at 108 Steele Road, West Hartford, Conn., **FLOYD C. GUSTAFSON** was sales manager for Chandler-Evans Corp., same city.

ROBERT M. COKINDA has been promoted from technical representative at Shell Oil Co., Inc., in New York, to division lubricants engineer in Baltimore.

Now in the employ of Permanente Products Co., Oakland, Calif., as a technical adviser in the general sales office, **DON A. LAWLESS** was connected with Reynolds Metals Co., Louisville, Ky.

Following his resignation as assistant project engineer with Curtiss Wright Corp., Caldwell, N. J., **PAUL W. LEAK** has become associated with the engineering department of the Norma-Hoffmann Bearing Corp. in Stamford, Conn.

WILLIAM RUSSELL is now with Ranger Aircraft Engines, Farmingdale, L. I., after completing 18 months' field service as technical representative on the west coast.

Formerly fuel engineer with Vacuum Oil Co. of South Africa, Ltd., Cape Town, **WILLIAM H. HIGHAM** is now

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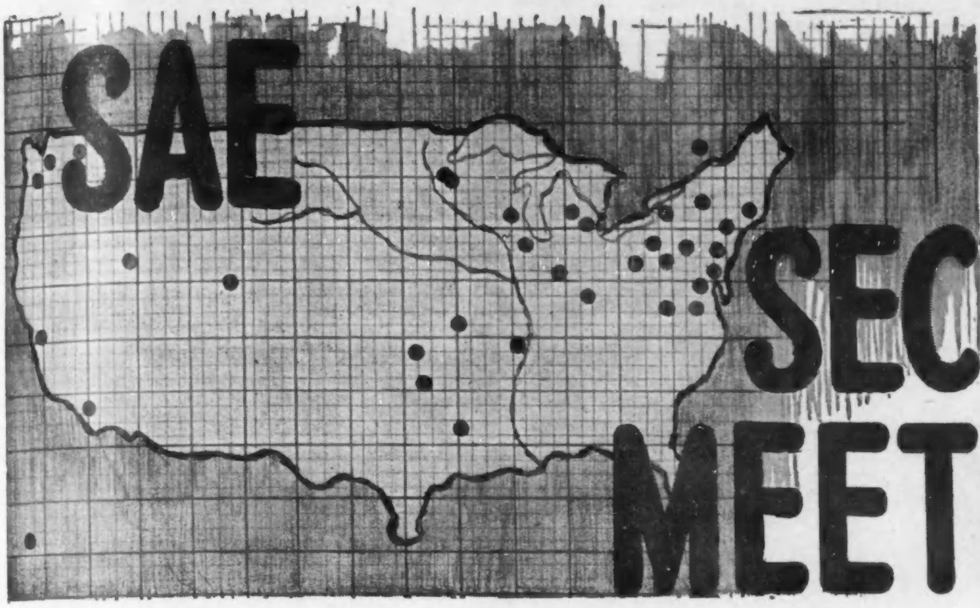
SAE SECTION MEETINGS



Shielding Needs Limit Atomic Use

by J. H. MACPHERSON, Field Editor

NORTHERN CALIFORNIA Section, Jan. 14 – Coal and oil have little to fear as yet in competition with urban atomic powerplants. In fact, Burton J. Moyer predicted at this meeting, the atomic powerplant probably will first appear in a location remote from coal or oil sources, and about 10 years will be required for atomic powerplant development even for such applications.

Moyer, who is physicist in University of California's Radiation Laboratory and a member of one of the Manhattan District Advisory Committees on Atomic Power, outlined at this meeting the future of atomic power as visualized by qualified scientists.

Speaking on "Technical Uses of Atomic Power," he described the operation of the atomic pile, consisting of a lattice of lumps of uranium metal supported in a moderator of graphite. Neutrons emanated from the uranium are slowed by the moderator so that the chain reaction between neutrons and uranium fission can be sustained. Thermal energy released by the fission or uranium molecules is absorbed by a heat transfer fluid which flows through pipes embedded in the atomic pile. Energy from this heat transfer fluid is transferred to a second fluid such as steam which is used to operate a steam turbine and electrical generator as in the conventional steam powerplant.

Application of atomic power to airplanes faces a serious difficulty: the necessity for very heavy shielding to protect the crew from dangerous radiation. If planes approach such sizes that the fuel load is 70 tons or more, atomic power can compete with other forms of propulsion. Such fuel loads are greatly in excess of the 20-ton fuel load of present air transports such as the Lockheed Constellation. The shielding problem also precludes use of atomic power in automobiles, but it may be possible to adapt this form of propulsion to marine uses. Extensive work will be required to develop shielding materials for such applications. Lead and cement are now used. Hydrogen ion is also a satisfactory material, the presence of water providing the shielding properties of cement.

In explaining the mechanisms by which atomic piles generate energy, Moyer indicated that isotypes produced in such piles may be used in the production of either bombs or radioactive materials for the production of atomic power. This fact makes the strong supervision of atomic research necessary for world peace because research work ostensibly directed toward peaceful power production could be converted to the making of bombs.

"Operation Crossroads" was shown vividly in a technicolor sound movie provided by the University of California.

CLOSING DATE

SAE Journal strives, in these pages, to bring to Society members live, prompt news coverage of every Section meeting. Material is provided by section field editors.

With dates determined by printing schedules, this issue covers all Section meeting news received in New York up to March 15.

Huge New Non-Stop Army Bomber Described

by EARL L. CASEY, Field Editor

TEXAS Section, Feb. 21 – New Army bomber that can take off in the United States with an atomic bomb and fly to any inhabited place in the world and return was described at this meeting by B. A. Erickson, supervisor of flight testing for Consolidated Vultee Aircraft Co. The XB-36 Bomber, Erickson said, is designed to carry a 10,000-lb bomb load 10,000 miles, and will control as easily as an ordinary aircraft. It is equipped with six 3000-hp engines with 19-ft, 3-blade propellers; engines are pusher type to take full advantage of wing surface. Main landing gear tires on the prototype are 18 ply, and 19 ft in diameter. Controls are electrically operated on a-c and d-c, the former used to reduce wiring weight. Generators, direct and alternating, are driven from the main engines with hydraulic motors, to maintain constant speed.

Erickson said he was not at liberty to discuss the plane's speed, but that its load could be expressed as about three boxcar loads.

Because of the plane's extreme length, the pilot can only be conscious of what is behind him, since he can see only the nose. In reality he makes two landings, first the main landing gear and then the nose wheel.

Erickson showed pictures of the third through the eighth experimental take-off and landing. First take-off was made without much load other than necesary gasoline and supplies. Each successive flight carried a heavier load until a total weight of 79,000 lb was reached on the last flight. Each landing was made with some engines idling or with power cut back. It was possible, he said, to fly and land with three engines dead.

Production model is to have four wheels on each landing gear instead of large single tires.

Plan Vocational Aid Program for Students

by C. E. BURKE, Field Editor

WESTERN MICHIGAN Section, Feb. 5 – This Section took part today in the first of a series of student activities. Programs are directed by W. A. Wiseman, chairman of the Section's Education Committee. Plans call for supplying speakers for a series of monthly meetings of the Muskegon Junior College Engineering Club. Speakers will be largely engineers, chosen from representative industries. They will speak on vocational guidance topics. By outlining their jobs and responsibilities, they will give students an idea of what to expect in industry. It is suggested that the speakers give, if possible, specific examples of the application of college engineering courses to their everyday duties.

Western Michigan's field editor was the first speaker. He is engineer in charge of development in the Experimental Department of Continental Motors Corp., and spoke on the workings of that department. About 40 students attended this first meeting, despite the fact that Muskegon was in the midst of a paralyzing snowstorm and zero weather.

Burke outlined the activities of the engineers in the Experimental Department, showing procedure followed in developing a new engine and problems involved in working out engines for special application. Test equipment was described in detail. Nature of the work made it comparatively simple to list many specific cases of the use of knowledge gained in college engineering, mathematics, physics, and metallurgy courses.

Representatives of Western Michigan Section and of Muskegon Junior College's Engineering Club are shown at the first Section-organized meeting of the Club. Left to right are: Section Vice-Chairman Paul Fuller; Club President Bruce Wathen; F. Rode, professor of mechanical engineering; Section Past-Chairman W. A. Engstrom; Education Committee Chairman W. Wiseman; and C. E. Burke, field editor and first of a series of speakers to be supplied to the club by the Section

Supercharging How, Why & When Explained

by DAN P. CHENEY, Field Editor

NORTHWEST Section, March 7 – You can't simply mount a supercharger on an existing engine and expect to increase engine output 50%, C. R. Jones of Cooper-Bessemer Corp. told this meeting. To do the job right, almost every part of the engine must be redesigned.

How much power can be got out of a given size engine without shortening engine life depends, he explained, on design of equipment and supercharging method employed. Most practical method for larger units, he said, seems to be the exhaust-driven supercharger, as it is flexible and needs no driving power.

After his talk, Jones showed two motion pictures prepared for the Cooper-Bessemer Corp. – one on injection systems and the other a detailed history of Cooper-Bessemer, showing also how modern Cooper diesels are built.

There was considerable interest in and some discussion of the company's use of cast Meehanite crankshafts. Such shafts now are accepted by the U. S. Navy Bureau of Ships for marine installations, Jones said. Careful metallurgical control, he added, has made possible uniformity of quality of the shaft material. Such shafts are used primarily in the slow-speed industrial engines, turning up to 800 rpm maximum.

Jones mildly shocked automotive maintenance men who think of stroke and bore in terms of 4, 5 and 6 in. by referring to small engines as anything under 10-in. bore.

Says Precision Vital In Bearing Production

by ROBERT B. INGRAM, Field Editor

WILLIAMSPORT Group, March 3 – Importance of precision control in the manufacture of bearings and bushings was emphasized here by H. P. Gusdane, of Cleveland Graphite Bronze Co. Control is of special importance during the continuous application of a bearing material to the steel bearing back and during the bearing-plating processes. This was pointed up by a motion picture of detailed steps involved in manufacturing precision sleeve bearings and bushings at Cleveland Graphite Bronze Co.

After Gusdane's film the group saw another picture entitled "New Automobiles," prepared by the Automobile Manufacturers Association. Film showed that the automotive industry is going to considerable lengths to keep its production lines rolling. To do this job, immense "follow-up" departments are necessary, and to meet critical shortages, raw materials often must be flown in by special air transports.

Limits Are Defined For Atomic Power Use

by C. E. BURKE, Field Editor

WESTERN MICHIGAN Section, Feb. 27 – In its present stage of development, atomic power could be used industrially only by large plants able to set up the proper equipment and obtain the correct personnel, according to Dr. Ernest F. Barker, chairman of University of Michigan's Department of Physics. Even with conditions at their best, he explained, there would always be danger to workers from an eventual slip at one point or another in the handling of necessary materials.

Barker reviewed the principles of the molecular theory, pointing out vividly the minute size of a single atom. He described the original carbon pile built at the University of Chicago where atomic disintegration was first effectively controlled.

Ashes left after atomic fission are very radioactive and extremely dangerous, he said. Disposal of these ashes constitutes a large problem.

C. T. Doman Honored At Section Meeting

by C. W. SIMMONS, Field Editor

SYRACUSE Section, Jan. 21 – This Section's annual social meeting drew 86 members and guests on one of Central New York's worst nights. Theme of the evening was "Doman Night," in honor of the recent election of Carl Doman, vice-president and chief engineer of Aircooled Motors, Inc., as SAE vice-president representing Aircraft Powerplant Activity.

Prof. Louis L. Otto, Section past-chairman, reported on the Annual Meeting. Section Chairman John Williams acted as master of ceremonies, introducing all the Section past-chairmen present, as well as Hollister Moore, manager of SAE Sections and Membership Division. Carl Roth, president of Aircooled Motors, talked about Doman as a man and engineer.

The party was a decided success from the dinner to "lights out," thanks to the competent handling of preparations by Section Chairman Williams and Curtis Armbrust, publicity chairman. About 86 attended, including some from the Elmira Division.

Syracuse Section Chairman John Williams (right) congratulates Carl Doman (center) while SAE Staff member Hollister Moore looks on

Highways, Atom Bombs Vie at Hilo Meeting

by W. O. HARPER
Secretary, Hilo Division

HAWAII Section, Feb. 14 – Motion pictures of the Bikini atom bomb test and a talk about Hawaii County highway problems by HC Chief Engineer John L. Padgett featured the bi-monthly meeting of Hawaii Section's Hilo Division at the Hilo Yacht Club. Attendance totalled 40.

Members and guests were welcomed by Hawaii Section's Hilo vice-chairman, Howard Overman, while Malcolm H. Love (SAE member from Honolulu) sketched briefly SAE aims and services. Hilo Division Secretary W. O. Harper read the minutes of the preceding meeting.

Turbine Best on Big HP Tasks, Editor Says

by E. S. TOMKINSON, Field Editor

PEORIA Section, Jan. 27 – "The gas turbine will not compete with diesel engines of less than 2000 hp for at least five years," Stan Tucker, gas turbine editor of "Power" reported. Speaking before a joint SAE-ASME meeting on the status of the gas turbine in the power field, Tucker presented data gathered on a survey trip during which he visited every important gas turbine shop and research activity here and abroad.

Present gas turbines, he said, are best adapted for large installations, of 5000 hp and up. All gas turbine plants built and being built have been designed for some specific purpose – not to replace some other form of power.

In Tucker's opinion, the gas turbine missed the best five years of its life by not being ready for locomotive use when railroads were beginning to abandon the steam locomotive. However, the locomotive field still is expected to be a fertile one for future gas turbines.

Coal-burning gas turbines have not been very successful because turbine blades coke up. Most widely used fuel to date is Bunker C oil, lower in cost than most diesel fuel.

Furnishing air for blast furnace operation is a job for which the gas turbine is well suited, since it can utilize the blast furnace gases. Installation cost would be about half that of steam turbine and boiler. Gas turbine efficiency now ranges from about 17% to 34%.

Tucker also described the Comprex pressure exchanger, a device under development by Sulzer Bros. Co. that is "to the gas turbine what the supercharger is to the diesel engine." It makes use of pulsation peaks in the air stream, increasing intake air pressure from four atmospheres to 10 or 12 atmospheres with the expenditure of very little energy. In a Swiss locomotive, it made possible a 60% increase in turbine output.

Farm Record: Fewer Workers, More Output

by EARL S. TOMKINSON, Feld Editor

PEORIA Section, Feb. 24 – Increasing mechanization is responsible for steady increase in farm production despite decreased farm population, SAE President C. E. Frudden told this Section in the first of a series of talks to SAE Sections.

Cooperative action through SAE has been potent in the reduction of tractor and equipment costs which have made mechanization possible, he explained, mentioning specifically standardization of tractor tires sizes, hitches, power take-offs and safety controls.

Truck gardeners, he said, are now greatly interested in small-sized tractors, while other farmers are finding use for such units as second tractors. The large number of city-dwellers moving to farms as a hedge against inflation are becoming a prolific market for the smaller types.

The president sketched briefly the organization structure of the Society, governed by its Council consisting of six Councilors, eleven vice-presidents

representing the eleven professional Activities, the two most recent past-presidents, a treasurer and president. He credited the headquarters staff of 110 workers with large responsibility for success of many SAE projects.

Supplementing the President's remarks, R. C. Sackett, manager, SAE Detroit Technical Committee Office, summarized the organization and work of SAE technical committees, all of which function under the direction of the SAE Technical Board. He stressed the major contributions to the war effort made by these committees and cited the saving of vast amounts of scarce alloys by development of substitute steels as an outstanding example.

Frudden closed his talk with showing of a specially assembled color movie showing new harvesting machines and other tractor-operated equipment in action.

WINSLOW

. . . . of Northern California

Charles A. Winslow is reported to have been an engineering enthusiast practically from birth. An incurable and often destructive curiosity about pianos and clocks and their innards was partly responsible, he suspects, for his having been sent to school when the time came.

Competition between school and mechanical inclination became a problem by the time he reached age 15. So he became an apprentice in the steam engineering department of the Mare Island Navy Yard. His professional life since those early days of apprenticeship in the drafting room, pattern shop, foundry, machine shop, blacksmith shop and boiler shop has been varied and always productive.

C. A. Winslow

He shipped out in 1908 on the Prometheus – one of the first large ships finished at Mare Island – and followed marine engineering for about 10 years, until the gas engine became the predominating means of marine propulsion for all small commercial vessels. Then he plunged into the technical study, design and development of equipment for improving internal combustion engines.

Before he was 30 he had organized the Winslow Mfg. Co., and burned a good deal of midnight oil in development of new automotive devices in the field of lubricating systems and filters. Introduction of Winslow oil and air filters to the automotive trade five years later took Winslow into closer contact with the industry, and he was consultant for many years in problems of design and development of lubricating systems, oil and air filter installations, and other products.

Exit of the heavy-duty gas engine found him pioneering in the design and development of small high speed diesels – marine, stationary and automotive.

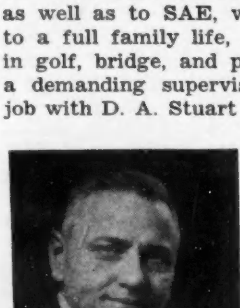
In his time away from Winslow Engineering Co. and the SAE, he can be found in his home in the Oakland hills, on his power cruiser "Hobby II," at his ranch near the ocean in Sonoma County, or hunting deer on his Lake County property.

– by J. H. Macpherson, Field Editor.

SMITH

. . . . of New England

Frank Wesley Smith, genial and aggressive, has managed to cover a lot of territory, professional and otherwise, since his student days at Stevens Institute and the U. S. Naval Engineering School. He has contributed an abundance of effort to such organizations as the ASME, ASM, ASTE, and New York Oil Trades Association as well as to SAE, without handicap to a full family life, an avid interest in golf, bridge, and photography, and a demanding supervisory engineering job with D. A. Stuart Oil Co.



F. W. Smith

His entry into industry as assistant superintendent in the mechanical department of Standard Oil's Bayway, N. J., refinery was cut short when he enlisted in the Navy, to hold successive rank from machinist's mate second class to ensign.

After the war he was lubrication engineer and supervisor of lube oil sales for the Texas Co. for eight years. Until 1943, when he joined Stuart, he was supervising engineer and manager of lube oil in Boston and New York for Cities Service Co. At the same time he was developing and testing automotive and industrial lubricants, and supervising and developing powerplant and test equipment.

Mr. and Mrs. Stuart have two sons. One is studying architectural engineering at the University of Pennsylvania. The other enlisted in the U. S. Marine Corps and recently was appointed to Annapolis.

– by Arnold R. Okuro, Field Editor.

This is the seventh installment in a series of biographies of 1946-47 SAE Section chairmen. Next month three more field editors will report on their Section chairmen.

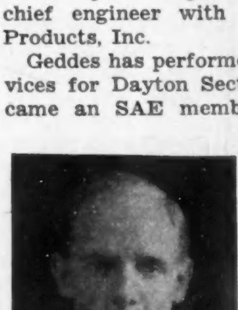
GEDDES

. . . . of Dayton

W. Hayward Geddes is a young man who has made the standard steps to engineering success rapidly since his graduation from Rensselaer Polytechnic Institute in 1934.

In six years he advanced from his first position of laborer and draftsman with the Louden Machinery Co., to junior engineer with the American Flange & Mfg. Co. and GMC's Harrison Radiator Division, and then in 1940 to his present position of assistant chief engineer with United Aircraft Products, Inc.

Geddes has performed diversified services for Dayton Section since he became an SAE member in 1942, and



W. H. Geddes

has filled most of the Section offices at one time or another.

Heat transfer problems fascinate him, and rank with bridge and golf as a favorite hobby.

– by James E. P. Sullivan, Field Editor.

Cites Advantages Of New A-C Welders

by J. B. TOMPKINS, Field Editor

BRITISH COLUMBIA Group, Feb. 12 – Design, current control and arc striking ability were cited as major improvements in current a-c transformer type welders by C. Arthur Lind of Scott Foster & Co., Ltd. Speaking before 140 members and guests on "Some Recent Developments in Arc Welding Equipment," Lind climaxed his talk with a Disney-produced animated color film depicting the evils of "distortion" in modern welding methods.

Early models of a-c transformer-type welders, he said, were inefficient because (1) they were not rugged mechanically and electrically; (2) current control was by electrical taps on the secondary circuit; (3) arc striking was poor; (4) penetration was low, particularly at point of weld; (5) arc stability was poor; (6) open circuit voltage was dangerous; and (7) power factor was low and few electrodes were designed for use with a-c current.

Current control on the new machines, however, is obtained not by troublesome electrical taps but by mechanical movement of one coil in relation to the other, or by varying the reluctance of the magnetic flux circuit with a movable iron core.

This feature, Lind said, provides continuous variation of current rather than a limited number of "heats." Arc striking on the new "huskier" design transformer welders is claimed to be as easy as with a d-c. Adaption of an "arc-booster" allows, for a short period after striking, all or part of the full transformer output to flow through the arc. The same part controls penetration at the start of each bead, so that welds equal in quality to those obtained with d-c equipment may be obtained.

Danger is eliminated, too, by use of low voltage – between 55 and 60 v – and power factor is higher so that condensers are seldom required.

New electrodes, he said, have a high penetration, exceptional ductility, high density, and are ideal for vertical and overhead welding. Hard-facing electrodes are being developed for a-c, and as demand grows, other alloys such as stainless steel, aluminum and bronze will be added.

Discussion following Lind's paper disclosed that:

• Though electrodes for welding auto blocks with transformer-type welders had been developed prior to the war, the process had been shelved because of high nickel content.

• Penetration with a-c is not as deep as with d-c equipment.

• Amount of distortion with new higher speed machines hinges largely on the amount of weld required or the amount of metal required for the bond.

• Main ingredient of fluxes used with transformer-type welders is cellulose that actually burns to form a gas shield keeping out air. Some fluxes are largely minerals, used as stabilizing and slag-forming materials.

• It is easier to weld aluminum with electric welding than with other means.

Oregon Section's Reception Committee in a not-very-serious moment: left to right, Otto A. Struss, Kenneth H. Mutch, Ed Dagner and J. Verne Savage

Residual Stresses Must Be Oriented

by L. A. WILSON, Field Editor

MILWAUKEE Section, March 7 – March meeting of the SAE Milwaukee Section was highlighted by the presence of two distinguished official visitors – SAE President C. E. Frudden, and Hollister Moore, Manager of SAE Sections and Membership. President Frudden spoke briefly on "SAE Activity for 1947," dealing mainly with organization, membership, budget, and services to members and industries.

In a technical talk on "The Effect of Residual Stresses on the Fatigue Strength of Structural Materials," J. O. Almen, head of Mechanical Engineering 1, Research Laboratories Division, General Motors Corp., demonstrated how the strength of structural materials can be greatly increased by the proper development and orientation of residual stresses, and how stresses resulting from heat treatment may be beneficial in some cases and harmful in others.

Almen characterized the prevailing theories and practices used in stress analysis and structural design as faulty in many respects, and suggested a need for textbook revision. He asserted that "stress" never has been calculated, and never will be. The laws and formulas for calculating loads are based on the premises that the material is homogeneous, isotropic and elastic. These are all false assumptions, necessitating the use of "factors of doubt." They simply acknowledge that we don't know what we are talking about, and in consequence many of our structures are overdesigned, particularly where we can't rationalize by experimentation.

The speaker used two strips of ¼-in. plate glass to demonstrate the effect of residual stresses. The glass had been heated to slight plasticity, and cooled on the outside first, in order to establish compressive stress at and near the surfaces, and tensile stress internally. One of the specimens had been annealed to remove residual stresses, the other had not. Each in turn was placed on end supports and subjected to a transverse bending load centrally applied. The annealed specimen broke under a relatively small load, while the strip in which residual stresses were high withstood 200 lb without breaking. Almen pointed out that there is no local yielding in glass, and that glass under static conditions behaves like metal subjected to repeated loading. A machine element must be run within the elastic range of the material. In fatigue failure there is no plastic flow. The microscope is commonly used to see differences in

Washington Section's annual ladies night, Feb. 11, offered cocktails, dinner, a string trio and an opportunity for the wives to see what happens at SAE meetings. After-dinner entertainment was furnished by Lee Webster Selfe, a Section member, who gave an exhibition of psychic magic. Two SAE past-presidents were present—A. J. Scaife and Dr. H. C. Dickinson

structure of metals, as in the case of carburized steel which has a hard shell and a tough interior. Hard materials are often thought of as brittle, but this is not the case when residual stresses are present. Failure in hard material is due to brittleness, Almen said. Martensite increases the volume, therefore added stress is introduced whenever a phase change occurs.

Shot peening was cited as a very effective method of increasing fatigue durability. In general, surfaces are weaker than the underlying layers. There can be no failure in compression, however; all failures on the surface start on the tension side, and stop when they reach the region of compressive stress, Almen declared. A number of slides were shown to illustrate this point. One was a picture of a carburized gear in which tension in the core resulted in internal fracture of all the teeth, yet the fractures had not penetrated the region of compressive stress in the hard outer carburized area. In flame hardening gear teeth, high internal stresses in tension are introduced. Stress at the surface from carburizing may be around 100,000 psi, but the normal procedure is to ignore this stress because of lack of knowledge about it. In most cases a tensile test gives the wrong answer because machine parts are seldom used in tension. According to the text books any increase in stress brings the part nearer to failure. Actually an increase in stress may result in increased strength, the speaker asserted. Rubbing a hone over a surface induces a compressive stress. Shot peening puts shallow layers of compressive stress in the surface. Fatigue strength is increased by shot peening if not carried too far.

Flame cutting introduces internal stresses. All welds are stressed internally and should be treated because it is the wrong kind of stress. Induction hardening may decrease the fatigue strength of a crankshaft. With induction hardening we aren't getting the best out of it, the speaker claimed. Tensile stress and surface vulnerability together make a bad combination. Carburizing and nitriding are similar treatments in that both involve heating all the way through, while in surface hardening the core is not heated. Grinding causes residual stress because the heat generated in the grinding operation leaves a very thin layer at the surface in a state of tension, hence grinding of gear teeth may be damaging, though dimensional errors are reduced. Polishing destroys 96% of the potential fatigue life. Shot peening carburized gears increases fatigue strength. Shot peening after grinding introduces compression in place of tension if the surface is not cracked from grinding.

Overloading a spring may make it stronger, Almen said. Shot peening must be done before overstressing, otherwise failure results. In other cases it is best to shot peen last. Shot peening increases the strength 20 to 50%. In olden times, the equivalent of shot peening was realized by hand hammering.

Commercial Vehicles Use War-Proved Aeronautic Hydraulic Power Systems

by R. A. GOEPFRICH, Assistant Field Editor

CHICAGO Section, March 11 – Successful performance of power hydraulic system in the operation of various components in military aircraft gave impetus to their consideration for similar duty in postwar commercial vehicles. So said Speaker G. W. Pontius, chief engineer of the New Devices Section of Bendix Products Division in his talk on "Hydraulic Controls for Commercial Vehicles." Over 250 members and guests attended, including a large contingent from the South Bend Group.

Pontius described an experimental installation on a 35-passenger bus, which has been in operation for over a year. Basically, the hydraulic units for aircraft and automobile use are the same. Specifically, for automotive use, the system consists of a pump, accumulator, pressure regulator, reservoir, brake control valve, brake operating cylinders, power steering gear, windshield wiper, engine temperature control unit and door controller with necessary valves and operating cylinders. A hydraulic throttle control is provided when the engine is remotely situated.

All units of both pressure supply system and hydraulically-actuated components were described, with the help of slides which showed first a photograph of the unit and then a cross-sectional drawing of it. Housings of most of the components were made of iron castings, but it was pointed out that further weight reduction could be effected with light-weight metals.

Pump is a gear type, with a displacement of 1¼ cu in. per revolution, and is driven at approximately crankshaft speed. Overall efficiency varies from 70% at engine idling speed to 76% at 3000 rpm. Operating pressure

range of the power system is between 800 and 1000 psi, maintained by a regulator interposed between the pump and accumulator. Accumulator is a 10-in. sphere containing a bladder with air pressure on the other side. This is the same unit that was in production during the war for aircraft use.

Brakes are operated by admitting fluid, which is under pressure in the accumulator, into hydraulic cylinders which spread the brake shoes into the drum. Pressure is controlled by a treadle-actuated valve, which is balanced in all positions to minimize hysteresis: approximately the same cylinder pressure will exist for a given treadle position whether that position is attained when it is being depressed or released. The time lag from the moment the foot touches the treadle until pressure required for maximum deceleration is reached is only about 0.2 sec, and brake release is somewhat faster.

Electrical control and hydraulic actuation are combined in the door operating system to simplify plumbing. Control handle may be set to open either the front or rear door, or both. Double-acting hydraulic cylinders operate the doors. A positive pressure is maintained in one end of the cylinder to keep the door firmly closed. Rear wheel brakes are automatically applied when the doors are opened and automatically released when the doors are closed.

In the engine temperature control servo, hydraulic pressure from the accumulator is used to control the position of the radiator shutter. A temperature-sensitive element actuates a valve to regulate the hydraulic pressure. The shutter is moved in small increments, each increment of movement following a temperature differential of approximately 3 F. Thus, this control maintains a more nearly uniform engine temperature than may be obtained with a control which positions the shutter either fully open or fully closed.

The windshield wiper motor is operated by hydraulic pressure from the accumulator acting on a pair of pistons which have rack teeth engaging a pinion on the wiper blade shaft. Compensating means are provided for keeping the operating speed constant, notwithstanding high and low power limits from the accumulator and variations in the frictional drag of the wiper blades.

Three types of power steering gears were described. One was a power system adapted to the Ross gear, a second one adapted to the Saginaw gear, and a third one in which the entire assembly is concentrically arranged about the axis of the steering column. Basically, the operation of all is similar; oil under pressure is permitted to act on either one end of the piston or the other to supply additional power to the steering gear linkage. In addition to making the vehicle easy to steer under all operating conditions, this type of power steering will effectively absorb all objectionable impact, or violent reaction, so that none is transmitted to the driver's hands. In the heaviest vehicles, there is no "wheel fight" when striking the curb, broken pavement, mud, abrupt road shoulder, and so on, and even with blowouts of large tires, complete control is maintained.

Movies were shown of an M-6 tank and a J. D. Adams road grader, both equipped with power steering gears, operating over extremely rough terrain. Pictures made it obvious that power steering is mandatory for these vehicles in this kind of service.

A lively discussion after the paper evidenced the Section's keen interest. Pontius skilfully answered many questions on power steering, pointing out that in addition to the safety features it offers, it makes even the heaviest vehicle steer as easily as a passenger car. Much interest was shown in weights of the respective units.

W. H. Oldacre, Section chairman, opened the meeting, and the speaker was introduced by B. E. House, vice-chairman of the Parts & Accessories Activity.

GE Expert Defines Gas Turbine Trends

by H. F. TWYMAN, Field Editor

KANSAS CITY Section, Feb. 13 – Definite improvements must be made in the present gas turbine power plant to ready it for commercial and general service, according to Ray E. Small, who is in charge of General Electric's Installation Design Section of the Aircraft Gas Turbine Division.

Speaking to this meeting of the Kansas City Section, Small listed as needed: greater reliability (especially of accessories); improvement in control system; longer life of sheet metal parts; improved efficiency through closer quality control, closer tolerances. A variable nozzle, he said, will obtain higher cruise efficiency, cooler starts and better acceleration. A higher take-off thrust can be obtained with water plus alcohol injection and the bleed-burn cycle.

Present engineering planning, Small revealed, is considering the reheat cycle or tail-pipe burning, higher pressure ratio across the compressor (perhaps 20 or 50 to 1 as compared to the present approximately 4 to 1), the most effective configuration for each required range of speed, determination of how big the power rating should be, the frontal area, overall proportions for specific installations, and how much weight and complexity is justified to get better specific fuel consumption for long-range operation.

In closing, Small called particular attention to potential advantages of powdered coal as a gas turbine fuel and predicted that, eventually, the gas turbine will take its place alongside other power units as a reliable and economical source of power.

A GE-Walt Disney film, titled "Jet Propulsion," together with slides depicting gas turbine aircraft installations and turbosupercharger installations on commercial and military craft supplemented the talk.

Sixty-five members and guests evinced high interest by the intensity and length at which they questioned Small during the discussion period. Particularly interesting in discussion were Small's descriptions of methods for conducting heat away from anti-friction bearings to improve lubrication and also use of ceramic coatings on sheet-metal parts to extend service life.

Piston Ring Trends Panel Meeting Topic

by C. F. FOELL, Field Editor

METROPOLITAN Section, Feb. 6 – Newest trends in piston rings, especially as they apply to diesel engines, were the subject of a very successful panel meeting held by this Section. Speaker was Helmuth G. Braendel, chief engineer of Wilkening Mfg. Co., Philadelphia. He discussed design, ring coatings and cylinder wall finishes.

Outstanding in design is increasing use of narrower face widths, twisted rings, and wedge-shaped rings of about 15-deg included angle. More rapid seating, better control of blowby and reduced ring sticking are secured from one or more of these features in various combinations.

Coatings are of two types: those that give rapid wearing-in and those that provide better-than-average life. Included in the former group are phosphate, oxide and graphitic coatings that possess oil-holding ability and thus tide over periods of marginal lubrication; soft metallic coatings of tin, lead and cadmium that melt under heat produced by metallic contact and so release molten metal which serves as a lubricant; and ring fillings of porous and chemically-inert substances that absorb oil for later release during temporary dry conditions. Chrome-plated rings are the chief example of the long-life type.

Cylinder-surface finishes are leaving the field of extreme smoothness in favor of the "interrupted" surface. This finish provides a pattern of countless small grooves and plateaus, whose purpose is to increase oil-holding ability and capacity of the surface. Any carbonaceous matter filling the grooves acts as a sponge to hold oil for eventual release at a dry period. The interrupted surface has proved to be exceptionally

resistant to scoring and scuffing, and to add materially to ring and wall life. Interrupted surfaces are produced by controlled scratch honing, followed by just enough passes with a smoothing stone to remove burrs and feathers.

Deep interest of the audience was evidenced by the long question and answer period that followed, as well as the many informal discussions that occurred after the panel was formally declared closed. Richard Creter, Metropolitan Section vice-chairman for Diesel Engine Activity, arranged the meeting and acted as presiding officer.

Fuel & Engine Experts Say Adaptation is Key

by W. F. SHERMAN, Field Editor

DETROIT Section, Feb 3 – Many modern aspects of the problems of fuels and engine cooling were presented to Detroit Section members at this meeting. With papers on these two subjects was a dinner talk which related the story of the first scientist of Old Detroit, a hundred years ago.

Speakers were Dr. W. G. Lovell, "Application of Fuels to Engines;" E. W. Bogan, "Passenger Car Engine Cooling," and George W. Stark, on "The Little Doctor."

Twenty-three years of Lovell's career have been spent in the Research Division of General Motors Corp., where he is assistant head of the Fuel Department. Of fuels and engines, he said:

"It has become trite to say that they must be mutually adapted to each other. It is only through measurement of both fuels and engines in definite related terms that specific progress can be made."

It is not enough to make engines as good as the available fuels or to make fuels just good enough to meet engine requirements, he said. The economic facts are that improved fuels can be produced at a low enough increase in cost so that, when used in suitable engines, the customer gets more miles per dollar. The problem he outlined is to decide what is a suitable engine and "for what kinds of fuel."

At this point he led his listeners into an appreciation of the difference between various octane number rating methods, such as Research, ASTM, and Road. Fundamental facts upon which he expanded are:

Knocking tendency of a fuel is a limitation to development of power by engines.

Some fuels are superior to others in respect to freedom from knock.

Incidence of knock of a fuel depends upon the kind of engine and conditions under which it is run.

Relative superiority of fuel depends upon engine characteristics and operating conditions.

"There is no general answer to the question of which of two fuels is better, unless the engine conditions under which they are used are defined."

Fuels have been usefully defined or rated only by comparison with other fuels and specifically in terms of mixture of heptane and iso-octane, thus giving rise to the octane number scale. The Motor Method (ASTM) is based on use of standard CFR laboratory engine under specified conditions. The Research Method is based on a similar comparison in a similar engine, but under other conditions. The Road Method makes use of secondary reference fuels in road tests.

The problem of fuel ratings is simple in principle, but right now is in a state of flux, Lovell stated.

The problem of engine ratings is another side of the fuel rating problem. It can be done usefully only in terms of available reference fuels. Some engines are "severe" and others are "mild" in reference to "sensitive" and "non-sensitive" fuels. The so-called sensitive fuels are fundamentally the cheaper ones so it is an advantage if the designer can produce a "mild" engine in the future to permit the use of the cheaper fuels.

Lovell concluded with the statement:

"What is important is this mutual relationship between fuels and engines is that either fuels or engines alone are of no use; it is only the combination the customer wants."

Bogan, head of the Engine Cooling Laboratory, Chrysler Corp., devoted his discussion to the engineering and test work performed on liquid-cooled passenger car engines. Objective of the testing is to develop a cooling system that is both economical and satisfactory.

Economy, he said, involves the cost of important components of the cooling system . . . the radiator as well as the other parts . . . and they should give maximum cooling performance per dollar.

Performance of the cooling system must be satisfactory under the divergence of climatic conditions and altitudes under which passenger cars must operate.

In many of its phases, design progress has brought special problems for cooling engineers. Larger powerplants, higher engine speeds, closer manufacturing tolerances and, most of all, more streamlined body designs have plagued cooling engineers with problems.

Originally cooling problems were handled by the radiator manufacturers, Bogan declared. But the trend has been for vehicle manufacturers themselves to assume a greater share of the research work.

He described components of the cooling system, starting with the grille and including the radiator, fan, thermostat and water pump. Details of radiator core structure and thermostats were illustrated by slides. Water pump details and performance details also were depicted.

Major part of Bogan's paper dealt with cooling system testing, especially radiator testing apparatus, engine dynamometer heat rejection tests, and cooling performance road tests. The latter were described in detail to help provide criteria for evaluating cooling performance.

Bogan concluded that the tendency to reduce the size of radiator grilles may result in the use of higher pressure cooling systems than are already in use, although such systems are costly to install. He mentioned the possibility that, some day, aircooled engines may be widely used but predicted that "it is highly probable that sealed cooling systems using permanent types of antifreeze liquids may receive wider acceptance in automobile engine cooling."

Stark, of The Detroit News, and official historiographer, told the story of Dr. Douglas Houghton – popularly known as "The Little Doctor" – the co-discoverer of major copper deposits in Northern Michigan.

Houghton, trained principally in the sciences of chemistry and natural history, was also a doctor of medicine, a surgeon and a dentist. With a brilliant background, he was invited to Detroit by the community when he was nineteen years old, at a time when the frontier city was recovering from the triple disaster of Asiatic cholera, a huge fire, and the effects of the War of 1812.

Not many years later, he and Dr. Sylvester Higgins, a topographer, made their explorations which resulted in the development of the mining territory of Northern Michigan. Houghton Lake and Higgins Lake are named for these pioneers.

Predicts Few Auto Changes Before '49

by C. W. SIMMONS, Field Editor

SYRACUSE Section, Feb. 3 – Joseph Geschelin, Detroit editor of Automotive and Aviation Industries, was guest speaker at the joint meeting of this Section and the Technology Club of Syracuse at the latter's headquarters in the Museum of Fine Arts tonight.

Speaking on "Passenger Car Trends and Development in Engine Design," Geschelin pointed out that other than the postwar Studebaker and the possible introduction of the Tucker rear-engine-driven car, there will be no radical changes in passenger car powerplants or exteriors before 1949. Geschelin believes the availability of

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CALENDAR

of Section Meetings

Baltimore – April 7

Engineers Club; dinner 7:p.m. New Developments in Truck Rear Axles – F. W. Parker, Jr., assistant to president, Timken-Detroit Axle Co. Guest – C. E. Frudden, consulting engineer, Tractor Division, Allis-Chalmers Mfg. Co., and president, SAE.

British Columbia Group – April 9

Hotel Georgia, Vancouver; dinner 6:30 p.m. The Use of Automotive Parts in Industrial Equipment – Lloyd T. Graves, Canadian Mixermobile Co., Ltd.

Buffalo – April 18

Hotel Westbrook; dinner 7:00 p.m. Keeping 'Em Rolling – W. W. Kunz, superintendent of equipment and buildings, International Railway Co. Trip through Garage and Overhaul Shops of International Railway Co.

Cleveland – April 14

Hotel Carter; dinner 6:30 p.m. Truck Selection – J. N. Bauman, vice-president, in charge of sales, White Motor Co.

Colorado Group – April 23

General Iron Works, Englewood; meeting 8:00 p.m. Adapting Automotive Equipment and Construction Apparatus to Service in a Public Utility – T. C. Smith, engineer, American Telephone & Telegraph Co.

Detroit – April 7 and 21

April 7 – Horace H. Rackham Educational Memorial Building; dinner 6:30 p.m. Dinner Speaker – George Cushing, news editor, WJR. Subject – Before the Microphone. Broadening our Engineering Horizons – J. H. Van Deventer, director of information, Committee for Economic Development.

April 21 – Horace H. Rackham Educational Memorial Building; meeting 7:30 p.m. New Hydraulic Applications for Tomorrow's Automotive Designs – M. A. Hayden, applications engineer, Vickers, Inc. Slides and exhibits.

Kansas City – April 22

Hotel Continental; dinner 6:30 p. m. Aeronautical meeting. Speaker and subject to be announced.

Metropolitan – April 17

Hotel Pennsylvania, New York; meeting 7:45 p. m. Additive Oils – Their Uses and Abuses – P. V. Keyser, Jr., G. A. Round, and J. P. Steward, Socony-Vacuum Oil Co.

Milwaukee – April 4

Milwaukee Athletic Club; dinner 6.30 p. m. Torsional Vibration – Wayne Greve, Le Rio Corp.

New England – April 18

Massachusetts Institute of Technology Graduate House; Cambridge; dinner 6:45 p.m. The New Tucker Car – Preston T. Tucker.

Northern California – April 7

Engineers Club, San Francisco; dinner 6:30 p. m. Considerations of Reynolds and Mach Numbers as They Effect the Design of Airfoils – D. J. Graham, Ames Aeronautical Laboratory, NACA. Slides.

Northwest – April 4

Hotel Gowman, Seattle; dinner 7:00 p. m. Motion Picture by Cleveland Graphite Bronze Co. Sleeve Type Bearings. Speaker to be announced.

Peoria – April 28

Hotel Jefferson; dinner 6:30 p. m. Engine Accessories – Superchargers, Fans, Water Pumps – Kurt A. Beier, chief engineer, Schwitzer-Cummins Co.

Philadelphia – April 9

Engineers Club; dinner 6:30 p. m. Some Aspects of the Transit Bus Picture – M. C. Horine, sales promotion manager, Mack Mfg. Co. Guest – C. E. Frudden, consulting engineer, Tractor Division, Allis-Chalmers Mfg. Co., and president, SAE.

Pittsburgh – April 22

Webster Hall, dinner 6:15 p. m. Mellon Institute, meeting 7:45 p. m. The Rolls of Detonation Waves and Auto Ignition in Spark Ignition Knock as shown by Photographs at 40,000 and 200,000 frames per second – C. D. Miller, aircraft engine research laboratory, National Advisory Committee on Aeronautics.

St. Louis – April 8

Hotel De Soto; dinner 6:30 p.m. Powering Our Future Cars – A. T. Colwell, vice president, Thompson Products, Inc.

Southern California – April 10 and 24

April 10 – Production Meeting. Speaker and subject to be announced.

April 24 – Transportation and Maintenance Meeting. Speaker and subject to be announced.

Southern New England – April 2

Hotel Bond, Hartford; dinner 6:30 p. m. Inspection trip through United Aircraft Corporation Wind Tunnel, East Hartford, immediately after dinner.

Spokane Group – April 11

Hotel Desert; dinner 6:30 p. m. How Chemistry Simplifies Automotive Cleaning Methods and Procedures – Ted Warnes, Turco Products Co.

Washington – April 8

Hotel Twenty-Four Hundred; dinner 7:00 p.m. Engineering "Whys" of the Modern Tractor – C. E. Frudden, consulting engineer, Tractor Division, Allis-Chalmers Mfg. Co. and president SAE. Motion picture – Tractors at Work.

Wichita – April 10

Airway Cafe, Inc., dinner 6:45 p.m. Gas Turbines for Aircraft, W. W. Williams, Beech Aircraft Corp. Brazing for High Temperature Service in Gas Turbines, Rocket Motors and Exhaust Stacks – Howard A. Smith, Beech Aircraft Corp. Motion Picture.

Williamsport – April 7

Home Dairy; dinner 6:45 p. m. Trends in Future Bus Design and Transportation – W. E. Williams, ACF Brill Motors Co.

SAE NATIONAL

PERSONAL AIRCRAFT MEETING

MAY 1-2

The Lassen Wichita

THURSDAY, MAY 1

MORNING 10 a.m.

Introduction
– Tom Salter, General Chairman

Welcome to Wichita
– Russell McClure, City Manager

Evolution of an Automatic Variable-Pitch Propeller
– J. D. Waugh, Aeromatic Propeller Dept., Koppers Co., Inc.

Better Propellers for Light Pocketbooks
– J. F. Haines, Aeroproducts Div., General Motors Corp.

AFTERNOON 2 p.m.

Engines for Light Aircraft
– D. S. King, Lycoming Div., Aviation Corp.

Problems of Helicopter Powerplants
– Robert Insley, Continental Motors Corp.

Fuel Injection versus Carburetion for Personal Airplane Engines
– G. M. Lange, Ex-Cell-O Corp.

EVENING 8 p.m.

The Relationship of Aircraft Detail Design to Tooling and Manufacturing Cost
– W. A. Davidson, R. E. Saunders, P. E. Pelley and J. W. Rix, Beech Aircraft Corp.

Comparison of Use of Mixed Structural Materials and Fabric Covering to All-Metal Construction for Personal Aircraft from a Manufacturing Viewpoint
– W. C. Jamouneau, Piper Aircraft Corp.

FRIDAY, MAY 2

MORNING 10 a.m.

Development of the Beech V Tail
– M. J. Gordon, Beech Aircraft Corp.

Symposium on Possible Powerplants for Small Aircraft

Design for Power Soaring
– E. H. Rowley, Boeing Airplane Co., Wichita Div.

Experiments with Converted Automotive Engines for Light Aircraft Powerplants
– A. W. Mooney, Mooney Aircraft Co.; H. C. Funk, Funk Aircraft Co.

Adaptation of Automotive Electrical Equipment for Personal Aircraft
– J. B. Hiday, Delco-Remy Div., General Motors Corp.

AFTERNOON 1 p.m.

Luncheon and Inspection Trip
– Cessna Aircraft Corp.
Duane Wallace, Host

AFTERNOON 3:30 p.m.

Control and Stability Characteristics of a Simplified Helicopter
– Charles Seibel, Boeing Airplane Co., Wichita Div.

SATURDAY, MAY 3

MORNING

Inspection Trip Through Beech Aircraft Corp.

■ DINNER ■

6:30 P.M. FRIDAY GRAND BALLROOM

"A New Approach to the Flight Problem" – W. B. Stout, Consulting Engineer

Tom Salter, Chairman
C. E. Frudden, SAE President

Frank E. Hedrick, Toastmaster
Coordinator, Beech Aircraft Corp.

Student Branch News

Fenn College

Fenn College Student Branch made a field trip through NACA's Engine Research Laboratory at Cleveland Airport on Feb. 21.

Members were oriented with a brief talk about characteristics and performance of the engines being tested at the Laboratory, and saw slides of the engines.

They were taken through the engine performance laboratory, altitude wind tunnel, icing tunnel, buildings housing accessories for the various laboratory test cells and wind tunnels, and the hangar in which planes for actual flight tests are kept.

Among planes assembled were the "Black Widow," the B-29 Superfortress, and the B-24, all of which have been converted into flying laboratories. Each has some sort of ramjet or turbojet engine in its bomb-bay.

After the plane reaches a suitable altitude the jet engines are started. Engineers in the plane take engine performance data in flight from the various gages, dials, and monometer tube banks in the plane's laboratory.

Tests are made above Lake Erie so that engines can be safely jettisoned if necessary.

The unique wind tunnel can take a full-scale engine and accessories, and simulate altitude conditions in flight. Item of interest in that building was a turbojet engine that had failed the evening before. The engine had become too hot and the turbine blades had "burned up."

In-flight icing conditions are simulated in the icing wind tunnel. Frigid air at flight speed passes through the tunnel, and data on icing conditions are collected. At the time of the tour a P-51 fuselage was suspended in the tunnel.

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Third meeting of the Fenn College student branch was held on Feb. 28 in the Fenn Tower. Chairman Raymond F. Hitti opened the meeting, welcomed guests from the Case student branch, and introduced George Tanker, Cleveland Section's new student activities chairman.

Tanker, who is project engineer for Weatherhead Co., told members about the present and future Section-sponsored activities for Fenn and Case enrolled students – among them a student dinner meeting scheduled for March 19.

Speaker of the evening was John Sanders, chief of the engine performance branch of NACA's Engine Research Laboratory.

Speaking on "Reciprocating and Jet Engines, Their Theory and Performance," Sanders discussed relative merits

of the propjet, turbojet, pulsejet and ramjet engines. He compared propulsive efficiency of the jet engines at different flight Mach numbers, and also the propulsive efficiency and kinetic energy supplied by the propulsive systems.

Power of the turbojet engine, he said, is greatly increased by "tail-pipe burning." He evaluated possibilities of the ramjet, pointing out the amazing horsepower it can produce at supersonic speeds. In conclusion, he discussed past and future use of rocket projectiles in warfare.

Lawrence Institute of Technology

Groups of L.I.T. students, on three successive days in January, made step-by-step inspection of processing of tubing at the Standard Tube Co., now operating in the old Ford plant near the Institute in Highland Park. Arrangements for the field trips were made by Activities Committee Chairman Robert Estler with the cooperation of Messrs. Marlowe and Ofenstein of Standard Tube's engineering department.

The group watched all the steps in the processing of tubing for irrigation purposes. Starting from the flat metal stock, the sheet metal was rolled around a mandril and formed to the desired cylindrical contour. Passing under a rotating circular electrode, the longitudinal joint of the cylinder was welded by a low frequency alternating current. In final operations the tubing was hydrostatically tested and treated metallurgically to prevent corrosion.

Singled out for special attention by the inspecting group were the electric welding apparatus and the electronic process controller. Monthly output of the firm is an imposing 5,000,000.

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At L.I.T.'s Jan. 27 student branch meeting, Dr. Viohl of U. S. Rubber Co.'s Motor Product Division was guest speaker. He covered a wide variety of subjects pertaining to rubber, its uses, and its inherent characteristics. Highly stressed rubber was given particular emphasis. Highly controversial subject of synthetic versus natural rubber was given spirited attention in discussion.

Viohl left the group extremely conscious of how much their normal living and transportation in Detroit depends on rubber.

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Two L.I.T. student branch members were speakers at the Feb. 24 meeting. Robert Dailey and Jack Walden, who is also a member of the American Rocket Society, spoke on rockets, covering a short political history and some of the highlights of the development of reaction motors. They analyzed and explained briefly the operation of each of the more widely known types of jet and rocket motors.

Discussion following the talk was highlighted by interesting revelations about the most efficient method of using each type of motor, advantages and disadvantages of various liquid rocket fuels, and the need for additional research in aerodynamics at transsonic speeds so that these powerplants may be used by aircraft with a maximum effectiveness.

Number of individuals participating in the general discussion, and the scope of the material under consideration, clearly indicated that the members of this group not only are interested, but are giving considerable thought to the many aspects of engineering in the realm of reaction propulsion and its applications.

Northrop Aeronautical Institute

Although the helicopter still is too expensive for private ownership, James S. Ricklefs told students at their Feb. 13 meeting, its potentialities eventually should justify it to a greater extent even than present-day private planes.

Ricklefs, who is vice-president of Landgraf Helicopter Co., showed an interesting and informative film and told about the testing program and the advantages of Landgraf's H-2 helicopter.

Full membership attended this meeting, as well as a large number of visitors. The week before, 25 students went up to SAE Southern California Section's meeting in Los Angeles to hear two papers, on "Turbojets" and "Light Plane Engine Prospects."

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On Feb. 27, members heard Volmer Jensen, chief designer for the Volmer Aircraft Co., speak on the development of his new two-place pusher-type airplane, the VJ-21. It has a 75 hp Continental engine and a new type single wheel and outrigger landing gear.

In any new design, Jensen pointed out, the elimination of small defects plays a large part in the development. Testing brings out numerous factors not evident from calculations and drawings.

At the business session, members heard and accepted the student constitution which will be submitted to SAE headquarters with a petition for a charter and status as an SAE student branch.

Rensselaer Polytechnic Institute

A good creative engineer, RPI's student branch members were told at their Feb. 13 meeting, must have five qualities: curiosity, constructive discontent, imagination, knowledge of fundamentals, and a talent for simple design. Speaker I. B. Benson, of General Electric Co.'s Flight Division, told those present that if they expected to be creative they must not be afraid of being emotional or unconventional. Necessity, he pointed out, is not necessarily the mother of invention; many of our greatest inventions appeared useless and ridiculous at first.

L. A. Taylor, chairman of the Mohawk-Hudson Group, described briefly SAE's purposes, and invited the students to attend Group meetings.

Oklahoma A&M College

Diesel engines were compared with other kinds of power by Diesel Power Co.'s manager, Carl A. Tangner, at the February meeting of this student branch.

Transportation Dinner Program Expanded: ...TICKETS REDUCED

ANOTHER feature has been added to the program of the SAE National Transportation Meeting Dinner, to be held on Thursday evening, April 17, at The Stevens in Chicago.

Following his principal speech on "Wartime Experience Pays Transportation Dividends," Robert L. Biggers, president Fargo Division, Chrysler Corp., will display a 40-minute colored motion picture: "Operations Sleepless," depicting the operations of a Carrier Task Force during a four-day strike on an island objective. The picture was taken personally by Biggers during a three weeks' cruise in May 1946 with Admiral Marc A. Mitscher and his Eighth Fleet in the Caribbean.

Other speakers on the dinner program are C. E. Frudden, SAE president; W. H. Oldacre, chairman SAE Chicago Section; and R. H. Johnson and O. A. Brouer, who will serve as co-toastmasters.

To encourage a maximum attendance, the price of dinner tickets has been reduced from $6.60 each, as listed in the program of the meeting, to $5.25 each. For tickets, apply to Floyd Ertsman, Executive Secretary, SAE Chicago Section, 3538 South Wabash Avenue, Chicago 15, Ill.

SAE NATIONAL MEETINGS

MEETING	DATE	HOTEL
AERONAUTIC (Spring)	April 9-11	New Yorker New York
TRANSPORTATION	April 16-18	The Stevens Chicago
PERSONAL AIRCRAFT	May 1-2	The Lassen Wichita
★SUMMER	June 1-6	French Lick Springs French Lick, Ind.
WEST COAST T&M	Aug. 21-22	Biltmore Los Angeles
TRACTOR	Sept. 17-18	Schroeder Milwaukee
AERONAUTIC (Autumn)	Oct. 2-4	Biltmore Los Angeles
PRODUCTION	Oct. 20-21	Carter Cleveland
FUELS & LUBRICANTS	Nov. 6-7	The Mayo Tulsa
AIR TRANSPORT	Dec. 1-3	Continental Kansas City, Mo.
ANNUAL	Jan. 12-16 (1948)	Book-Cadillac Detroit

★ Highlighting the technical program of the 1947 SAE Summer Meeting will be two sessions with four papers in the form of a symposium on engine sludge . . . Charles F. Kettering will present a paper "Fuels and Engines for Higher Efficiency" . . . Engineering considerations of fiberglass for bodies will be among the more interesting materials developments to be reported . . . A study of valve seat inserts by A. T. Colwell is expected to be an outstanding engineering contribution . . . Automatic transmissions will be the subject of another symposium . . . Two sessions will bring engineers up to the minute on jet powerplants . . . H. L. Rittenhouse will tell what is new in off-the-highway vehicle design . . . The diesel engine investigations on cylinder wear will be advanced . . . 35 papers in all, by more than 40 authors and co-authors, are scheduled.

Overall thermal efficiency comparison, he said, reveals these figures:

Steam engines	6-11%
Gasoline engines	15-20%
Diesels	22-39%

Tangner discussed at length the possibility of using gas engines with butane for fuel. Thermal efficiency would be slightly higher than that of gas engines, and they would be much simpler in design and have lower maintenance cost. There is, on the other hand, the disadvantage of a probable fuel shortage: 50% of all available butane is already being used for household heating.

To illustrate low maintenance cost of such an engine, Tangner reported results of a 70-month test run in 1932 with a butane engine. Engine head was removed after continuous running, and the small carbon deposit on the piston head wiped off easily with a handkerchief; piston was as good as new.

Tangner announced, in conclusion, that during the war there was a 5000% increase in the use of diesel power.

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On March 3, the Oklahoma A&M student branch had as guests R. A. Darling, a graduate of A&M, and M. S. Kenady, both of the Cooper-Bessemer Corp. The speaker showed motion pictures entitled "Continuous Performance" and "The GMV," describing the engines produced by Cooper-Bessemer. In response to questions, Darling reported that scavenge and mechanical efficiency of the engine are respectively 130% and 87%.

Another film, "Tornado in a Box," produced by Allis-Chalmers, illustrated the mechanics of the gas turbine.

General Motors Institute

Students from General Motors Institute had a unique opportunity to examine operations closely when they visited the Chevrolet engine manufacturing and assembly plant in February. H. H. Renico, student representative from the Chevrolet Division, arranged to have the group taken through the plant by two of the top-flight supervisors, R. Dow and H. Peterson.

Guides not only knew most of the men on the shift personally, but also were capable themselves of operating almost any machine in the plant.

Ohio State University

Dr. M. J. Zucrow, of Purdue University's School of Aeronautics, spoke to Ohio State's student branch meeting in January. Outlining "Some Aspects of Jet Propulsion," Zucrow illustrated the various phases of jet propulsion with a series of slides.

On Feb. 3, L. R. Baker, director of the Graduate School of Chrysler Institute of Engineering, told students some of the qualities industry expects of young engineers. Particularly important, he said, is steadiness on the job. Baker commented on the value of the postgraduate training programs for engineers offered by most large industries.

Detroit Institute of Technology

D.I.T. student branch took advantage of the SAE Annual Meeting in Detroit this year to hear many of the papers presented. Before that, in keeping with the group's plan to visit as many Detroit industries as possible, they were guests of the Chrysler Corp. An enlightening tour of the testing laboratories enabled them to see what goes on in the carburetor section, lubricating oil laboratories and others.

Most of the other laboratories visited were similar to those at the Ford plant seen earlier, so that methods could be compared. They were particularly interested in X-ray techniques, fatigue testing machines, life duration tests for auto parts, and the universal application of strain gages throughout the entire plant.

Chrysler's progress in the field of powder metallurgy was clearly illustrated by the almost unlimited application of the process. They saw the modern sound laboratory where automobile noises are cut down to an absolute minimum, and, as a climax, were shown a plastic working model of the fluid coupling.

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better fuels in sufficient quantity and at economical prices in the next few years will make it possible for engine designers to depart radically from present engines.

Before the meeting, Geschelin was a guest of Syracuse Section for dinner at the Museum. Charles B. Spase, Section past-chairman and a vice-president of the Technology Club, introduced representatives of Syracuse industries that contribute products to the production of passenger cars, trucks and buses. Each representative reported contributions of his company, proving that Syracuse is an important spoke in the automotive industry wheel.

J&H Slide Valve Engine Story Told

by L. A. WILSON, Field Editor

MILWAUKEE Section, Feb. 7 – February meeting of the Milwaukee Section heard the story of the new high-performance slide-valve engine developed by Jack & Heintz, Inc., of Bedford, Ohio. Speaker was J&H project engineer, Richard H. Owens.

Jack & Heintz entry into the engine businesss, Owens said, started when Army Air Forces decided to change from hydraulic to electrical controls on the B-29 bombers and contracted with the company to develop a 5-kw engine-powered unit. Previously the company had been engaged in development work on mass production of aircraft accessories in which die-casting procedure was employed to make high production possible with good quality and low cost. The slide-valve type of engine was chosen for the new unit because it was better adapted to die-cast fabrication than a poppet-valve engine would be. To be suitable for airborne service it had to be extremely light in weight. This led to development of a high-speed, air-cooled engine with two horizontally opposed cylinders and designed for a peak output of 30 hp at 6000 rpm. Subsequently, in anticipation of the need for larger engines for big flying boats, 4- and 6-cyl models also were designed with parts interchangeable with those in the 2-cyl engine in so far as possible. By V-J Day the management was convinced of the postwar possibilities of engines of this type and proceeded to design powerplants for automobiles, aircraft, refrigeration systems, and other applications.

Owens gave a detailed explanation of the various models developed, illustrated by slides. The cylinders in each case are 3⅛ x 2¾ in., giving 21 cu in. piston displacement per cylinder. The designs permit variations as required in different applications while using standardized parts for such things as cylinder heads, pistons, connecting rods, and valve mechanisms.

Motor blocks are die cast of aluminum in two identical halves, bolted together and finished as a unit. The die-casting machine built for this job weighs 75 tons. Die for the 2-cyl engine block contains about 300 parts and weighs 14 tons. A 20-ton machine was built for die casting smaller parts.

The cylinder assembly includes a cylinder sleeve, port ring, sealing ring, aluminum cylinder head, pressure spring, and reed-type seals. Separate inlet and exhaust valves, each with ports, slide between the cylinder and the die-cast block. Each valve is actuated by a mechanism consisting of an eccentric, a connecting rod, and a pivoted lever, the movable end of which is spherical and fitted into a socket riveted to the slide valve. Two such mechanisms mounted on a die-cast case constitute a standard eccentric unit.

Two of these units, one on top and one on the bottom of the crankcase, actuate the inlet and exhaust valves in the 2-cyl engine. The shafts that drive the eccentric units are made hollow to carry lubricating oil to the units, and are run at ¼ engine speed.

The crankshaft is formed by bolting together standard parts, each faced with 18 clutch teeth. This construction allows the crank throws to be fixed in the proper relative angular position for either two, four, or six cylinders, and permits different end arrangements as required. A complete crankshaft assembly includes the main bearings, connecting rods and pistons. The built-up construction eliminates the necessity of splitting the connecting rods and main bearings.

The high compression ratio of 8.5 to 1 is an added feature which accounts for high power per cu in. of displacement and low fuel consumption per hp per hr, Owens said. Generous use of die-cast aluminum and magnesium in the construction of these engines brings weight per hp down to a figure comparable with aircraft engines of equal power. Owens mentioned specifically the 6-cyl automobile engine which develops 90 hp at 6000 rpm and weighs only a little over 300 lb complete with transmission.

Views Are Varied On Wide-Base Rims

by R. W. DONAHUE, Field Editor

PHILADELPHIA Section, Feb. 12 – Wide-base tire rims increase tire life, improve stability and handling characteristics of vehicles, according to a rim manufacturer and a truck operator; but they are a headache to the engineer building large trucks and buses, according to a truck manufacturer. This difference of opinion, supported on the one side by W. S. Brink, Firestone Steel Products Co. and Emil Gohn, Atlantic Refining Co., and on the other side by B. B. Bachman, Autocar Co., emerged in a symposium on "Wide-Base Tire Rims" at this meeting.

Brink traced the development of tire rims from the advent of the pneumatic tire down to the present day, indicating that the evolution of modern tires has shaped rim developments. Advent of the war and its attendant rubber shortage, he said, made the problem of premature tire failure, particularly in large truck fleet operation, a critical one; and the program for development of wide-base rims was greatly accelerated.

It was found in tests that unusual stressing of tire side walls on vehicles with high c.g.'s could be reduced by increasing rim size, thereby broadening the effective contact area between tire and road. This improved stability and handling of vehicles that previously had poor roadability characteristics, and it reduced "cupping" on the tread. Optimum ratio of rim width to tire width was found to be 70%.

Gohn reported results of a brief survey among operators using wide-base rims; tire mileage was said to increase 15 to 40% with the new rim. Some operators reported savings in truck operating cost up to 60%. Additional comments indicated that side sway and rolling tendencies were corrected with new rims.

Bachman described problems confronting truck manufacturers attempting to apply wide-base rims to their vehicles. In 40 of the 48 states, he said, laws limit the overall width of trucks to 96 in. At the present time, large trucks are pushing these limits. In many cases, increased rim width pushes overall width of the vehicle outside the legal limit.

He also criticized rim manufacturers for not getting together and standardizing such parts as spacers between dual tires. As a manufacturer, he said, he would like to be able to pass along benefits of wide-base tire rims to his customers, but does not see how it can be done until laws permit increases in width limitations.

Sees Truck Payloads Upped With New Lighter Materials

by R. W. BIXLER, Field Editor

SOUTHERN CALIFORNIA Section, Jan. 16 – Lighter materials and better material distribution in design will do much to reduce truck weight and increase payloads, E. S. Ross told this meeting. The chief engineer of Peterbilt Motors reported, in answer to questions following his paper, that:

- In response to larger engines, larger area brakes are being designed for freer action, greater efficiency and easier maintenance;
- Trucks need not fear displacement by railroads, because of their special usefulness in serving expanding agricultural and other industries;
- Pressure undoubtedly will be placed on authorities to increase legal truck loading limits and provide roads to support these loads.

Watt L. Moreland, owner of the Moreland Motor Truck Co., and an SAE member since 1908, substituted as technical chairman for R. L. Koeppen. About 250 were present at this meeting.

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tary services, and 106 are employed as junior engineers.

Leading the list of institutions of higher learning are 187 at General Motors Institute. Twenty-three colleges have 20 or more SAE Enrolled Students.

There are 17 SAE Student Branches, which have been chartered by the Council, and six SAE Student Clubs which, as such, are serving a probationary period.

Each of these groups has a faculty adviser.

Local SAE Sections are called upon to provide occasional speakers to discuss engineering subjects with the group, and SAE meetings are open to Enrolled Students.

"Series" Sessions for French Lick

THERE will be no simultaneous sessions at the 1947 Summer Meeting at French Lick. Instead, four sessions each day will come one after the other. Morning sessions will begin at 9:30 a.m. as usual. Two afternoon sessions will follow – one from 1:30 to 3:30 p.m., the other from 3:45 to 5:45 p.m. Finally, there will be the usual evening session at 8:30 p.m.

Purpose of the change, Meetings Committee Chairman George Delaney explains, is to make every session available to every member in attendance. Meetings Committee decided to try the "series" idea following exhaustive discussion at its January meeting, where member suggestions for improvement of previous meetings were studied.

Army Seeks Investigators

FOR assignment to study European technical developments, the U. S. Army is seeking the services of about 85 qualified engineers. Pay, with allowances, will be about $10,000 per year, and it is expected that some of the engineers will be appointed to permanent assignments if they wish.

Contact by interested SAE members should be made with Lt.-Col. Glenn Wilhide, 1294 National Bank Building, Detroit.

Olley Represents SAE

MAURICE OLLEY, consulting engineer, Vauxhall Motors, Ltd., will represent the Society at the Centenary Celebrations of the Institution of

Mechanical Engineers, during June of this year.

Council accepted the British organization's invitation to name an official representative, and asked Mr. Olley, who has distinguished himself in both countries, to serve.

Machine Tool Congress

AN evening technical session will be contributed to the Machine Tool Congress, Sept. 16-26, by the SAE Production Activity. The Congress will be held in connection with the national Machine Tool Show, Cleveland.

SAE participation was requested of the Congress, and SAE Vice-President Stephen Johnson, Jr., recommended to Council that the invitation be accepted. Council approved.

Represented Frudden

GAVIN W. LAURIE, Atlantic Refining Co., and a past vice-president of the Society, represented SAE President C. E. Frudden at the formal dedication ceremonies of the new headquarters building of the American Society for Testing Materials, 1916 Race Street, Philadelphia.

The event took place on Feb. 28.

T & M Formulas

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the Public Roads Administration, will deal with tractive resistance. It will go beyond the factors of rolling and air resistance generally associated with tractive resistance. In its study of the subject, this group intends to determine – if possible – practical values for all forces opposing vehicle motion.

Third group, of which Robert Cass, White Motor Co., is chairman, will cover factors involved in tractive effort. Mr. Cass advised that the approach of his group will parallel that of Mr. Saal's.

Speed Airplane Air Conditioning

ENGINEERING know-how for attaining greater passenger comfort in airplanes is being developed by the SAE Aircraft Air Conditioning Equipment Committee in two proposed reports.

The first report, AIR No. 17, Air-

plane Air Conditioning Engineering Data, is to be a design data manual. The second, ARP 367, Airplane Supercharging Equipment, will specify general requirements for equipment used in pressurized airplanes.

Aircraft air conditioning is yet a relatively new art. The designer of airplane equipment faces many more variables than does the designer of ground air conditioning. Variations in altitude, atmosphere and air density complicate his job. The Committee intends to accumulate all available data and publish it in one easy-to-use volume as a design tool.

According to Chairman W. W. Reaser, Douglas Aircraft Co., Inc., the Committee plans to prepare AIR 17 as a supplement to AIR No. 2, Airplane Heating and Ventilating Equipment Engineering Data (published by the Committee on Jan. 1, 1943). The new report will contain sections on (1) properties of the atmosphere, (2) fluid dynamics, (3) heat transfer, and (4) thermodynamics.

Cabin supercharging for high-altitude flight is better understood by the industry. In tentative ARP 367, the Committee will spell out general pressurizing requirements as well as specific equipment design features and operating characteristics. This data will be based on actual field tests and experience.

Scheduled by the Committee for future development are a recommended practice on testing of airplane air conditioning equipment and one on thermal anti-icing equipment.

Full Facts Insure Better Universals

THE supplier will build better universal joints if he receives all pertinent information, the newly-issued SAE Aeronautical Recommended Practice 388 advises helicopter and airplane manufacturers.

ARP 388, Design Criteria for Universal Joints, was developed by the SAE Helicopter Committee primarily for selection of universal joints for helicopter rotors. It also is recommended as a helpful type of data sheet for other universal joint applications.

Aircraft manufacturers providing all the information called for in ARP 388 will insure a universal joint suited for its job, says the Committee.

Here is the kind of information that should be specified:

1. Type of vehicle – airplane, helicopter, or autogiro;

2. Purpose of universal joint – such as main helicopter rotor drive or tail rotor drive;

3. Torque and speed the joint must

transmit during various engine operating conditions;

4. Engine information – make and model, power and speed rating;

5. Operating conditions;

6. Installation data – permanent angle, fixed angle, axial movement, and dimensional limitations;

7. Sketch of installation – showing driving and driven members, engine, universal joint, transmission, and clutch;

8. Miscellaneous data on flange or spline connections and sizes.

Plan Specifications On Reflector Signals

SPECIFICATIONS for reflectorized warning signals, use of which is now authorized by the Interstate Commerce Commission and by a number of states, are under development by the SAE Lighting Committee.

Another Committee project that stems from ICC requirements is development of a suitable carrier for spare vehicle bulbs. (Under ICC rules, every vehicle subject to its jurisdiction must carry one spare bulb of each kind used on the vehicle.)

A recently approved revision to the SAE Direction Signal Lamps Recommended Practice says that the signal switch shall be reliability-tested through 50,000 complete cycles. The committee believes that tests of 50,000 cycles, rather than the 175,000 formerly specified, provide adequate assurance of the system's durability.

A new project undertaken by the committee is a specification as a basis for approval of motorcycle and scooter headlamps.

New Members Qualified

These applicants who have qualified for admission to the Society have been welcomed into membership between Feb. 10, 1947, and March 10, 1947.

The various grades of membership are indicated by: (M) Member; (A) Associate Member; (J) Junior; (Aff.) Affiliate Member; (SM) Service Member; (FM) Foreign Member.

Baltimore Section: John Perry Barker (J), Howard Charles Brown (A), Joseph Arthur Edwards, Jr. (J), Edward J. Jankovic (J).

British Columbia Group: Emerson Abernethy (A), Allan Alexander Wood (A).

Buffalo Section: Robert William Morgan (M), Ralph E. Valentine, Jr. (J).

Canadian Section: Thomas George Couch (A), George Albert Dowling (M), George Rex Fletcher (A), Vaughan E. Ireland (A), William P. Payne (A).

Chicago Section: Charles E. Capron (J), George R. Caskey (M), Edward T. Christian (A), Edward K. Dombeck (M), Edward J. Emond (A), Francis G. Fabian, Jr. (J), James Alfred Fitzgerald (J), Ford D. Johnson (A), Howard A. Offers (A), Rex A. Prunty (A), Walter H. Schachenman (M), W. Waits Smith (M), Walden P. Weaver (J), William E. White (J), Alfred F. Zornow (J).

Cincinnati Section: William J. Brinkman (M).

Cleveland Section: William D. Angst (J), George Henry Eckels (J), Charles Mackenzie Fluke (J), Vern Gordon Rollin (SM), David J. Sloane (J), John Toma (J), Robert M. Ward (J).

Dayton Section: Frank E. Carroll, Jr. (J), George Roland Ott (SM).

Detroit Section: Emmett W. Bond (J), Byron F. Campbell (M), Aymar De Bacourt (A), Capt. Henry Wilson Fer-

nandes de Souza (J), Elmer C. Dodt (M), Daniel P. Dyer, Jr. (M), Robert B. Edgar (A), Idan E. Flaa (M), Clinton S. Fulton (M), Merrill A. Hayden (M), Harvey T. Hendricks (M), George V. Hurley (A), Lawrence A. Hyland (A), Jacob A. Jacks (M), Kenneth M. Koch (J), William Louis Komph (M), Theodore A. Lenda (M), Hugh Douglas Lowrey (M), Evan Lucas (J), Harold F. Matthys (A), Carl A. Nystrom (J), Walter S. Praeg (A), John D. Shaw (J), Cleveland Walcutt, Jr. (M), Lawrence V. Williams (M).

Hawaii Section: Kaare Olaus Asper (A), Robert F. Butler (A), Daniel Thompson (A).

Indiana Section: William E. Judd (J), Sterling Kenneth Keyser (J), Abraham Smaardyk (J).

Kansas City Section: Louis R. Koepnick (M), Frederick V. Olney (A).

Metropolitan Section: Halvdan Aase (A), John Baier (A), Harold L. Belanger (J), Franz Campolmi (A), Sidney M. Caplan (J), John E. Drake (J), Jules Louis Louvet Dronet (M), Frank William Farrelly (J), (Miss) Vivian Ruth Goff (J), Herbert Blood Hubbard (J), Haworth William Hurt (A), Stephen Jack (J), George Vincent Judge, Jr. (J), Edward W. Koffman (A), James Maxwell Langley (A), John W. Limpert (M), Joseph Leonard McGinniss (J), David Miller (J), (Miss) Grace Eileen Musker (J), Edward B. Nisbet (A), Robert Wright Northup (J), William N. Plamondon, Jr. (J), Raymond A. Quance (J), John M. Schultz (J), William E. Simpson (J), Simon Soto (J), Nathan S. Stern (M), Herbert C. Towle, Jr. (J), Robert Leon Van Voorhies (J), Robert M. Youngs, Jr. (J), Aaron N. Waldman (J), Henry A. Waller (J).

Mid-Continent Section: William H. Easton (M), Henry Phillip Enders (A).

Milwaukee Section: Elmer William Bernitt (M), David Caldwell Gaston (A), John E. Harley (M), L. H. Schoenleber (M), Guy Scrivner (J), Otto A. Uyehara (M).

Mohawk-Hudson Group: T. Southworth (A).

New England Section: Paul G. Burman (M), George M. Schutter (A), J. Roy Smith (M).

Northern California Section: John R. Spreiter (J), Victor J. Westerfield (M).

Peoria Section: Robert S. Mills (J).

Philadelphia Section: Samuel E. Baily (A), Charles H. Dessin, Jr. (J), G. Jason Sawyer (A).

Pittsburgh Section: George Anderson Hinckley (A).

Salt Lake Group: Paul E. Thompson (A).

San Diego Section: Howard Russell Dentz, Jr. (J), G. D. McVicker (M).

Southern California Section: Walter Bennett (M), Robert Wayne Carr (A), George E. Dithridge (J), Hollis S. Dolan (A), Edward Robert Elko (J), Richard Freund (M), Peter Gilbert Gattie (A), Wilfred Camphadis Gibson (A), Fred V. Hall (J), James A. Hodges (A), Arthur Adelbert Mathewson, Jr. (M), James David Mooney, Jr. (J), Michel C. Palmer (M), Terry M. Prudden (J), Clinton B. Ridgell (A), Geneste Radnor Taylor (A), LeGrande W. Whitman (A).

Southern New England Section: Allen L. Brownlee (M), John H. Flaskamper (A), Leo Raymond Leggitt (J), Ernest J. Mailloux (M), Francis W. Powers (J).

Spokane Group: Harold C. Besgrove (A).

Syracuse Section: Stuart Hamilton (J).

Texas Section: James Burr Powell (A), Frank M. Stripling (M).

Virginia Group: David T. Ayres, Jr. (J), Percy J. Carr (A), Clarence Harley Wees (A).

Washington Section: Ray B. Roberts (A).

Western Michigan Section: Warren F. Kalkstine (M), Bine W. Rollin (M).

Wichita Section: R. H. Willey (J).

Williamsport Group: R. P. Graham (J).

Outside of Section Territory: William F. Broker (J), Donald C. Brush (J), Sidney John Kelly (J), Richard U. Skarshaug (A), Wendell P. Turner (A), Huston Gilbert Welch (J).

Foreign: Jacques M. Camusat (J), France; Anthony Eskrigg Cooke (FM), England; John Glyn Davies (FM), England; Mohamed Mostafa El Alaily (J), England; Roland Howard Gapp (J), England; Joseph William Milton (FM), England; Alec Elliot Redhead (FM), India; Peter Reid (FM), India; Harold Walter Rogers (FM), England; Albert Shaw (FM), England; Sonnerdale Pty. Ltd. (Aff.) Rep: Stewart Leslie Sonnerdale. George Maxwell Tompkins (FM), South Africa.

Applications Received

The applications for membership received between Feb. 10, 1947, and March 10, 1947, are listed below. The members of the Society are urged to send any pertinent information with regard to those listed which the Council should have for consideration prior to their election. It is requested that such communications from members be sent promptly.

Baltimore Section: Robert G. Clark, Robert V. Rosenwald.

British Columbia Group: Roy H. Johnston, George F. Lloyd, John Randolph Wesley Young.

Buffalo Section: David Roy Shoults.

Canadian Section: Emmanuel E. Chauvin, Wilfred Ketringham Johnson, Edwin Lloyd Parsonage, Wilbur James Tate, Edgar Joseph Wadham.

Chicago Section: James E. Ashton, Wilbert Bernhardt, Howard S. Bowen, Aubren Oliver Cookman, Jr., Fred J. Gerling, Frank Hlavek, Marshall Dean Klinger, William C. Musham, Edward B. Nechville, Walter G. Newman, Kenneth D. Roubie, Stephen L. Shira, Leroy Francis Slivinski, G. D. Smith, Thomas A. Smith.

Cincinnati Section: John J. Beckstedt.

Cleveland Section: Fred R. Allin, William Elmer Brill, Richard H. Gale, John P. Henson, E. J. Hrdlicka, Jr., O. J. Kelley, Wesley E. Messing, Karl W. Schreeck, Walter M. Shaffer, Fred A. Wilcox.

Dayton Section: D. Franklin Boyd, George Ullman Crites, Adolf Eugen Rahm.

Detroit Section: William John Cooke, Boyde Clemens Cormany, Philip A. Essi, William K. Ginman, Lee Hall, A. E. Hess, Harold H. Klein, Howard Robert Lange, Tilford H. Morgan, Natwar Mulchand Parekh, William L. Petersen, Jr., E. O. Reynolds, William F. Rossiter, Arthur J. Shull, Robert E. Thibodeau, Raymond L. Turck, Karl Wanner, Light B. Yost.

Hawaii Section: Warren Williams Flagg, Rene Guillou, Erich E. Haenisch, Lewis S. McClure, Thomas Francis Pryor, J. H. Rastatter, John Davis Singleton, Bernard K. Smith.

Kansas City Section: L. B. Lingham, Dallas Vincent Walker.

Metropolitan Section: J. E. Campbell, Howard Day Chapin, John L. Chilton, Alton B. Crampton, Sam Louis Glasberg, Howard G. Ingerson, Jr., Samuel Paul Johnston, William Velsor Lessels, Albert J. Magee, J. O. McLean, Ernest

Francis Pollard, Paul R. Rindfleisch, Dilworth T. Robers, Charles A. Schweitzer, Max Herbert Spiegel, Victor Warshaw, Ernest A. Wildermuth, Jack Yampolsky, Yet Lin Yee.

Mid-Continent Section: James O. Chase, Merl D. Creech, Franklin Edward DeVore, W. F. Ford.

Milwaukee Section: W. J. Adams, Jr.

Northern California Section: Martin J. Duffy, Horton A. McKim, Vinton Curtis Ryland.

Northwest Section: Kenneth Dean Endelman, Stanley Power, Davis M. Wood.

Oregon Section: John Day Adams, Leonard A. Cox, Willis Harrison Stevens.

Peoria Section: John R. Gardner.

Philadelphia Section: William J. Fitzsimmons, Charles S. Knapp, Walter L. Newsom, Thomas Reynolds Pierpont, Bernard Miller Sturgis, James C. Wise.

Pittsburgh Section: Oliver B. Rosstead, Jr.

St. Louis Section: Charles William Brown, Hubert C. Moog, Robert Gerry Tuell.

Salt Lake City Group: Clyde William Sissman, Jr.

San Diego Section: Robert Millard Barr, Burt F. Raynes.

Southern California Section: George K. Anderson, Jr., Pierce F. Clarke, Robert Cyrus Lyon, James R. Neal, Ovila A. Richer, Robert G. Strother, Eric Swarthe, Ivan Turner.

Southern New England Section: Robert L. Ballard, Randolph P. Dominic, Glenn Maynard Douglass, Joseph Thomas Osterman, Byron T. Virtue.

Spokane Group: Glenn C. Connelly, Otto R. Fogle, Earl B. Maxwell.

Virginia Group: George W. Eary, Charles Wyndham Galloway, C. Dimmock Jenkins, George D. Thomas.

Western Michigan Section: Kenneth A. Chancellor, Irving F. Gillespie, Donald B. Miller.

Washington Section: Myles W. English, Lyman Carlyle Fisher.

Williamsport Group: John Kells Spangenberger.

Outside of Section Territory: Ernest F. Ling, Gordon MacLean, Howard R. Munshaw, Clarence T. Soenke, Harry B. Thompson, Jr.

Foreign: Jose Telleria Arana, Spain; Jean-Jacques Baron, France; Capt. Paget McCormack, Ireland.

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Novel Way to Compute Rotating Disc Stress

Digest of paper

By C. M. McDOWELL

Packard Motor Car Co.

(This paper will be published in full in SAE Quarterly Transactions)

A method for calculating the centrifugally caused radial and tangential stresses set up in a rotating disc is outlined in this paper. Mr. McDowell explains that:

The system involves a trial and error solution of a differential equation based on the equations of equilibrium and compatibility for a small element. In this differential equation, the second derivative of a stress function with respect to radius is related to the radius, wheel thickness, and radial stress of a small element and to Poisson's ratio, the mass density, and the angular velocity.

Chief tool in this method is the plot of a function of radial stress versus

radius. Slope of the curve is assumed at the outer radius where stress and radius are known, so that a small fragment of the curve can be drawn. From this curve, its slope and the value of the stress function can be read at a slightly smaller radius. The second derivative of the stress function – available from the differential equation – and the observed slope are substituted in the expression for radius of curvature. (This expression can be found in a calculus textbook.) With this radius, the trial curve of stress versus wheel radius is continued farther. The process of reading the stress function and its slope from the curve at a smaller radius, applying them in the radius curvature formula, and continuing the curve is repeated until the inner wheel radius is reached.

If the value of the stress-radius slope assumed at the outer radius is correct, the boundary conditions at the inner radius will be fulfilled. This usually means that the radial stress will be zero at the inner radius.

Values of radial and tangential stress along the wheel radius can be computed easily from the plotted stress function, once it has been determined correctly. The author reports that a satisfactory solution usually requires not less than three trials.

Also discussed in the paper are reasonable size of radial increments, shape to be expected in trial curve, and discontinuities in wheel contour. (Paper, "Stresses in Rotating Discs by Radius of Curvature Integration," was presented at SAE Annual Meeting, Jan. 7, 1947.)

Auto-Transmission Fallacies Debunked

Digest of paper

By A. H. DEIMEL

Spicer Manufacturing Division of Dana Corp.

REALIZATION that optimum results with hydraulic torque transmission depends on integration of converter design with the vehicle as a whole will dispel converter misconceptions, argues Deimel. He points out that:

Two common misbeliefs are that:

1. A hydraulic torque converter cannot compete with gear transmission on fuel economy, and

2. Converter torque multiplication is limited to a fixed ratio.

What misleads many on the first point are so-called torque converter efficiency curves. It is easily proved that efficiency of a unit as a torque multiplier is maximum when the "efficiency" curve shows it to be zero. The curve is merely the ratio of torque multiplication to speed reduction plotted against output speed in percentage of input speed.

These people fail to see the dependency of fuel economy on not only the torque converter, but also on the engine and other vehicle parts.

Clarifying Multiplications

For example, each shift with a multispeed gear transmission operates the carburetor throttle pump. Result: heavy fuel consumption. Additionally, only during a portion of operation in each gear is the engine running at its best fuel economy.

If a particular vehicle ran at constant speed and constant load on a constant grade of infinite length, a gear ratio could be selected for maximum efficiency outperforming any torque converter. But all vehicles start and stop and operate through varying speeds, loads, and grades. This is why the mechanical transmission must add

gear ratios or steps, while hydraulic transmission – with its infinite steps over a wide range – comes into its own.

But if maximum performance is to be obtained, good engineering of the entire vehicle is required.

An example of how engine design geared to hydraulic unit needs improved fuel economy and performance is the Twin Coach bus. Large percentage of engine horsepower delivered to the wheels in vehicle dynamometer tests pleasantly surprised bus operator observers.

How Fuel Is Consumed

A number of supposed authorities have claimed that a converter's torque multiplication has a top value, such as 2½ or 5. But they are selecting a specific converter and saying that all converters have its characteristics. This isn't so because you can get a 10 or 20 torque multiplication by building a single-stage, ten-stage, or twenty-stage converter.

Such converter may not be desirable for a vehicle transmission any more than would a pair of gears giving similar multiplications. A successful transmission must meet many requirements. Its design is the best compromise of all factors involved.

Basically the converter, or any transmission, is a connection between the source of power and the source of motion – wheels, tracks, or propellers. Best results derive from designing the connection to function under all operating conditions and to overcome the vehicle's resistance to motion to best overall advantage, be it a bicycle, truck, or tank. (Paper "Crawler Tractor Performance with Hydraulic Torque Converter Drive," presented at SAE Annual Meeting, on Jan. 9, 1947.)

About SAE Members

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captain in the South African Air Force, stationed in Pretoria, Tvl. S. A.

After having been in the U. S. Navy, **DONALD W. ENO** is now with Pan American World Airways in New Orleans.

WILLIAM F. HAYES, who is a field engineer for the Trundle Engineering Co., has transferred from Cleveland to Beloit, Wis.

ARTHUR W. WOODWARD, who had been an aeronautical engineer with the National Advisory Committee for Aeronautics, Cleveland, is now affiliated with the Curtiss-Wright Corp., Columbus, Ohio.

GRANT S. WILCOX, JR., has been promoted to staff specialist, from assistant master mechanic, at the Plymouth Division of Chrysler Corp., Detroit.

Now in the employ of LaPlante Choate Mfg. Co., Inc., Cedar Rapids, Iowa, as a project engineer in the engineering department, **JOHN A. JUNCK** had been a field research engineer for the Caterpillar Tractor Co., Peoria, Ill.

Having relinquished his position with the Detroit Gear Division of Borg-Warner Corp., **CARL H. SCHEUERMAN, JR.,** has now joined the Tucker Corp. in Chicago as project engineer.

After resigning his position as mechanical engineer, Aeronautic & Marine Engineering Division of General Electric Co., Schenectady, N. Y., **R. H. BRECKENRIDGE** has accepted a position with the Standard Steel Works in their Engineering Department.

FRED N. POTTER is now an employee in the Citrus Groves of Neil C. Potter, Lake Placid, Fla. He will assist in managing groves and will also supervise the maintenance and operation of irrigating equipment. He had been connected with the U. S. Navy Bureau of Aeronautics in New York.

AUSTIN S. EDWARDS, JR., is now working with the M. W. Kellogg Co., New York City, as a mechanical engineer in the Development and Materials Division. He had been senior test engineer, Wright Aeronautical Corp., Wood-Ridge, N. J.

ROBERT A. WELLS has been appointed sales engineer for the Aviation Division of Gulf Oil Co. of Pittsburgh, Pa., after having been field engineer for Wright Aeronautical Corp. in Wood-Ridge, N. J.

The appointment of **HENRY ROWOLD** as assistant general sales manager of Mack-International Motor Truck Corp. was announced recently. Rowold, also a vice-president of the company, combines his new duties with those of national accounts manager, a position he has held for some time.

H. G. LYMAN is now residing in Manila, P. I.

R. R. PARKER of the American Bosch Corp. has transferred from Springfield, Mass. to the Chicago branch.

Following his resignation as sales engineer of the Warren Refining & Chemical Co., Cleveland, **THOMAS R. BLAKESLEE** has been appointed sales engineer of the Federal-Mogul Corp., Detroit.

EDMUND A. GUZEWICZ has joined the Revere Corp. of America, Wallingford, Conn., as a development engineer. Before this he had been associated with the Pratt & Whitney Aircraft Division of United Aircraft Corp. in East Hartford, Conn.

C. B. SPECK is now associated with Link Aviation, Inc., Binghamton, N. Y., serving in the capacity of assistant project leader and consultant.

Before joining the Greyhound Corp., Chicago, as assistant general manager of maintenance, **JOSEPH M. SILLS** was staff engineer automotive, Socony-Vacuum Oil Co. in New York City.

Previously affiliated with Wright Aeronautical Corp., Wood-Ridge, N. J., as a junior engineer, **ROBERT M. YOUNGS, JR.** is now field engineer with the Pitometer Corp. in New York City.

Graduating recently from Purdue University, **JAMES N. LOW** is now piston ring engineer for the Burd Piston Ring Co., Rockford, Ill.

W. B. GARTHLEY is now connected with the Shell Oil Co., Inc., Sacramento, Calif.

WILLIAM T. GREEN, who is a division manager for the Double Seal Ring Co., has transferred from New York City to New Rochelle, N. Y.

WILHELM ORNSTEIN is now employed at the University of Pennsylvania as an instructor of mechanical engineering.

Before joining Waukesha Motor Co., Waukesha, Wis., as a technical writer, **ELWIN F. LINDSLEY** was associate editor of Scientific American Magazine in New York City.

ROBERT JUNTWAIT, who is a sales engineer for Wright Aeronautical, Ltd., in the Los Angeles office, recently transferred to the home plant in Wood-Ridge, N. J., serving in the same capacity.

Previously employed as an engineer in the engine development section of the Ford Motor Co. of Canada, Ltd., **JOHN W. ASSELSTINE** recently be-

came a project engineer in the commercial development section in the engineering laboratory of the Ford Motor Co., Dearborn, Mich.

Recently promoted to chief engineer at the Cleveland Wire Spring Co. in Cleveland, **E. H. JOHNSON** was sales engineer.

A. FRANK GEILER is no longer connected with Rockland Coaches, Inc., Spring Valley, N. Y., in the capacity of superintendent of maintenance. He is now executive vice-president and general manager of the Schnectady Street Railway Co. in Schnectady, N. Y.

THOMAS D. WALLACE, who had been a salesman for the Toledo Steel Products (Canada) Ltd., St. Catharines, Ont., Canada, has been advanced to factory representative, eastern Canada sales representative at the same company.

Now a member of the engineering department at A. B. Farquhar Co., York, Pa., **GEORGE H. STRAM** had been a product designer for the Clark-Babbitt Engineering Associates, Inc., Newark, N. J.

A. LESLIE CORE has now become associated with the B. F. Goodrich Co., Akron, Ohio, as an industrial engineer. Prior to this he was at the University of Michigan.

Formerly technical service engineer at Intava, Inc., New York City, **CARL E. HABERMANN** is now with the Greenpoint Laboratories of Socony-Vacuum Oil Co. in Brooklyn, N. Y. He was recently appointed chairman of the Metropolitan Section's Student Activity by Chairman **W. E. CONWAY.**

Promoted recently to manager of the Detroit branch of the Elco Lubricant Corp., **JOHN G. HAMMOND** was sales and service engineer at this company. They manufacture automotive gear lubricants.

After resigning as design engineer for Beech Aircraft Corp., Wichita, Kans., **LOREN J. JAMES** is now a partner in the Moran Truck & Tractor Co. in Moran, Kans.

R. H. LAMB, who is a factory manager for the Spencer Mfg. Co., has transferred from Detroit to Spencer, Ohio.

The name of the Washington Motor Coach Co., Inc., Seattle, Wash., has been changed to that of Northwest Greyhound Lines, Inc. **W. W. CHURCHILL** has been appointed assistant general manager. Other SAE Members employed at this company are **M. G. BARLOW** and **H. W. WICK.**

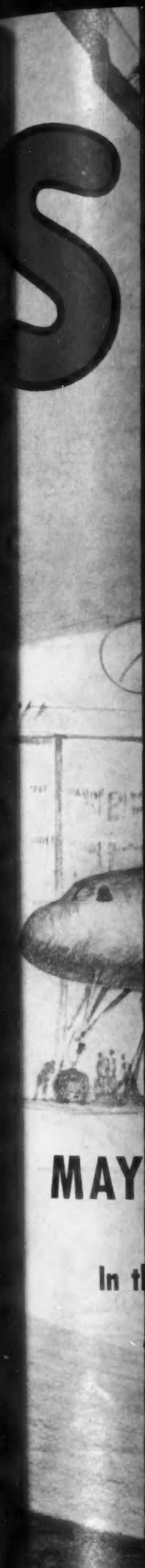
Now employed at the U. S. Navy's David W. Taylor Model Basin in the Aeromechanics Division in the capacity of project engineer, **RALPH F. BROBERG** had been flight test engineer for the Republic Aircraft Corp., Farmingdale, L. I., N. Y.

WILLIAM Q. DOUGLASS is no longer with the Diesel Engineering & Mfg. Corp. of Chicago, Ill. He is now associated with the Mall Tool Co., serving as a design engineer. This company manufactures gasoline, electric and pneumatic portable power tools.

After graduating from the University of Michigan, **CHIN-TSE YANG** is now a designer with the Stone & Webster Engineering Corp. in Boston.

Now in the employ of the Electric Bond & Share Co., New York City, as a transportation engineer, **RUSSELL LUNDBERG** was formerly division superintendent of maintenance for the National City Lines, Inc., Chicago.

Recently graduated from the University of Oklahoma, **EDMOND S. ALDREDGE** is now employed at the Carbide & Carbon Chemicals Corp. in South Charleston, W. Va.


MAY